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ABSTRACT

Developed to highlight the interrelationships between and among science, technology, society, and the environment, this guide offers educators ideas and activities, and identifies resources for instruction at the elementary and secondary school level. Introductory comments explain and support the role and importance of environmental education in Science/Technology/Society (STS) education. Environmental concerns, problems, and principles are identified and discussed in terms of their relationship to STS education; a list of 13 concepts serves as an index to the instructional activities offered in this guide. Activities are then presented according to grade level category (elementary, middle/junior high school, and senior high school). Each of the activities addresses an environmental concern and/or concept. Information on each activity includes: (1) purpose; (2) grade level; (3) subject area; (4) environmental concept; (5) reference source; (6) background information; and (7) actual activity. References are provided for both the activity sources and introductory section. (ML)

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SELECTED AND DEVELOPED BY

JOHN F. DISINGER AND MARYLIN LISOWSKI

TEACHING ACTIVITIES IN SCIENCE/SOCIETY/TECHNOLOGY/ENVIRONMENT

ERIC® Clearinghouse for Science, Mathematics
and Environmental Education
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ENVIRONMENTAL EDUCATION INFORMATION REPORTS

Environmental Education Information Reports are issued to analyze and summarize information related to the teaching and learning of environmental education. It is hoped that these reviews will provide information for personnel involved in development, ideas for teachers, and indications of trends in environmental education.

Your comments and suggestions for these publications are invited.

John F. Disinger
Associate Director
Environmental Education

Office of Educational Research and Improvement
U.S. Department of Education

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PREFACE

This is the 19th volume in ERIC/SMEAC's Teaching Activities in Environmental Education series, which was initiated in 1973. The first three titles in the series were of a general nature, dealing with multiple aspects of environmental education. Starting with the fourth, topical areas have been identified as themes, with the expectation that such an organizational pattern might prove more useful to practitioners in both formal and non-formal settings.

As a general rule, most of the activities selected for inclusion in the various volumes have been adapted from materials developed by others; many of the source publications have been reported through the ERIC data base, and are available as ERIC documents. Some have been "original," in the sense that ERIC staff or other authors have developed them more or less from scratch. Common formats have been employed for all activities in each volume.

The current volume was developed by John F. Disinger and Marylin Lisowski. Most of the activities are based on reports, instructional materials, and other information located through the ERIC system, as referenced. Activities include a mix of original and adapted materials.

Other titles in the Teaching Activities in Environmental Education series include:

John H. Wheatley and Herbert L. Coon, One Hundred Teaching Activities in Environmental Education. 1973; ED 091 172; 204 pages.

John H. Wheatley and Herbert L. Coon, Teaching Activities in Environmental Education, Volume II. 1974; ED 102 031; 200 pages.

John H. Wheatley and Herbert L. Coon, Teaching Activities in Environmental Education, Volume III. 1975; ED 125 268; 195 pages.

Herbert L. Coon and Michele Y. Alexander, Energy Activities for the Classroom. 1976; ED 130 833; 148 pages.

Herbert L. Coon and Mary Lynne Bowman, Environmental Education in the Urban Setting: Rationale and Teaching Activities. 1977; ED 137 140; 199 pages.

Judith M. Schultz and Herbert L. Coon, Population Education Activities for the Classroom. 1977; ED 141 178; 195 pages.

Robert H. McCabe, J. Terence Kelly, and Doris Lyons, Man and Environment Teaching Activities. 1977; ED 144 626; 336 pages.

Herbert L. Coon and Charles L. Price, Water-Related Teaching Activities. 1977; ED 150 026; 156 pages.

Mary Lynne Bowman and John F. Disinger, Land Use Management Activities for the Classroom. 1977; ED 152 541; 265 pages.

Mary Lynne Bowman and Herbert L. Coon, Recycling: Activities for the Classroom. 1978; ED 159 075; 145 pages.

William R. Hernbrode, Multidisciplinary Wildlife Teaching Activities. 1978; ED 162 897; 95 pages.

Herbert L. Coon and Mary Lynne Bowman, Energy Activities for the Classroom, Volume II. 1978; ED 173 072; 165 pages.

Mary Lynne Bowman, Values Activities in Environmental Education. 1979; ED 182 118; 134 pages.

Charles E. Roth and Linda G. Lockwood, Strategies and Activities for Using Local Communities as Environmental Education Sites. 1979; ED 194 349; 207 pages.

Mary Lynne Bowman, Teaching Basic Skills through Environmental Education Activities. 1979; ED 196 704; 132 pages.

Mary Lynne Bowman, Teaching Natural Resources Management through Environmental Education Activities. 1981; ED 214 752; 206 pages.

Lori D. Mann and William B. Stapp, Thinking Globally and Acting Locally: Environmental Education Teaching Activities. 1982; ED 229 214; 327 pages.

John F. Disinger and Marylin Lisowski, Teaching About Hazardous and Toxic Materials. 1985; ED 273 432; 270 pages.

NOTE: References to the sources of activities contained in this volume begin on page 148.

TABLE OF CONTENTS

	Page
Preface	iii
Introduction	xi
Teaching Activities	
Elementary School	1
Middle/Junior High School	47
Senior High School	93
References	148

CONCEPTS IN SCIENCE/SOCIETY/TECHNOLOGY/ENVIRONMENT EDUCATION

These concepts were selected from among those noted by Robert E. Roth, et al., Environmental Management Concepts-A List; University of Wisconsin Research and Development Center for Cognitive Learning, Madison, 1970. ED 045 376.

1. Environmental management involves the application of knowledge from many different disciplines. (pp. 10, 40, 54, 55, 68, 99, 104, 120, 131).

2. Social and technological changes alter the interrelationships, importance, and uses for natural resources. (pp. 3, 4, 7, 9, 12, 14, 16, 18, 26, 34, 42, 52, 54, 62, 74, 84, 91, 97, 115, 126, 127, 133, 137).

3. A cultural and time lag exists between the development of knowledge in science and technology and application of that knowledge to resource and environmental problems. (pp. 42, 75, 97, 124, 137, 143).

4. Management is the result of technical and scientific knowledge being applied in a rational direction to achieve a particular objective. (pp. 18, 24, 68, 84, 107, 128).

5. Options available to future generations must not be foreclosed. (pp. 3, 20, 42, 52).

6. A variety of institutional structures is involved in planning and managing the environment. (pp. 16, 22, 88, 109, 120).

7. The distribution or location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use. (pp. 4, 10, 12, 22, 30, 80, 97, 133).

8. Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, ethical, and economic considerations. (pp. 49, 55, 70, 75, 80, 99, 104, 139).

9. Conventional benefit-cost analyses do not always result in sound conservation decisions. (pp. 40, 82).

10. A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources. (pp. 49, 52, 55, 70, 88, 104, 109, 139).

11. Natural resources are interdependent, and the use or misuse of one will affect others. (pp. 14, 20, 87, 91, 107, 121, 128, 131, 133).

12. Pollutants and contaminants are produced by natural and man-made processes. (pp. 66, 95, 109, 118, 121).

13. There are certain risks taken, and limitations experienced, when manipulating the natural environment. (pp. 54, 64, 66, 86, 87, 95, 124, 128, 143).

ABOUT THE AUTHORS

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INTRODUCTION

With many others, Sterling (1985, p. 220) has proposed that a systematic, organic world view is needed to guide future thought and action for the environment, stating that an understanding of history is critical in the development of an integrated environmental ethic and proposing a philosophical framework that recognizes the integrity of human communities and natural systems in a modern technological world. He has listed a set of "inadequate, constraining, and mutually reinforcing values and assumptions which permeate the 'classical scientific worldview,'" rendering that view inadequate in today's world. His listing includes items dealing with humans as separate from natural systems, not recognizing the interconnectedness of phenomena and events, regarding knowledge and experience as distinct "subjects" and modes, regarding empirical knowledge as more real than the real world, divesting nature and human creativity of spiritual and aesthetic qualities, misusing the concepts of objectivity and neutrality, being reluctant to show commitment, seeing problems in cause/effect terms and preferring technical solutions to multidimensional approaches, preferring analysis to synthesis, and having little sense of desirable scale with regard to human activities.

This Teaching Activities Guide seeks to highlight the interconnections among school content areas as they relate to current, and likely continuing, concerns of this nature, which are typically expressed in terms of Science/Technology/Society Education. In particular, the framework employed here notes contributions that environmental education might make to the implementation of the S/T/S goals of general education, most specifically by highlighting environmental education-related activities which may be of value in the context of science education, social studies education, and within the educational enterprise in general.

A major goal cluster of Project Synthesis, a comprehensive research synthesis effort conducted by science educators during the past decade, stresses the central role of science education in producing informed citizens prepared to deal with science-related social issues (Kahl and Harms, 1981, pp. 7-8). Project Synthesis challenged science educators to a major redefinition and reformulation of goals for science education "to develop a curriculum which would focus on direct student experiences, technology, and personal and societal concerns" (Volk, 1984, p. 25).

Social studies educators generally address the S/T/S theme within the context of citizenship education, initiating their argument for the development of a scientifically literate citizenry from the Jeffersonian perspective: "Every government degenerates when trusted to the rulers of the people alone. The people themselves, therefore, are its only safe depositories. And to render even them safe, their minds must be improved" (Jefferson, 1785, p. 188). Patrick and Remy (1985, p. 1) currently note "... three kinds of challenges,...which are associated with the pervasive influences of science and technology in modern American society:

- the challenge of informing citizens about complex social issues and decisions related to advances in science and technology;

- the challenge of connecting in the school curriculum diverse fields of knowledge relevant to understanding decisions about complex social issues;

- the challenge of resisting antagonists of science and technology in our society, who threaten the integrity and success of scientific and technological ventures."

Those associated with the environmental education movement of the past twenty years have emphasized similar concerns. Though disagreement and some fuzziness with respect to definitions and terminologies have been associated with their efforts, proponents of environmental education generally have agreed that environmental education is aimed at (among other things)... "producing a citizenry that is knowledgeable about the biophysical and sociocultural environments of which man is a part, aware of environmental problems and management alternatives of use in solving these problems, and motivated to act responsibly in developing diverse environments that are optimal for living a quality life" (R. Roth, 1970, p. 6; after Stapp, et al., 1969, pp. 30-31).

More recently, Borden (1985) has traced the development of ecological thought and ideas and has suggested a "new human ecological perspective" stressing the need for metadisciplinary views and proposing greater exploration of the subjective, aesthetic, historical, and psychological implications of ecology.

The National Science Teachers Association (NSTA) has recognized the trend toward viewing science as a discipline appropriately concerned with the study of the interactions and mutual impacts of science and society (NSTA, 1978). As an emerging conceptual model for science education, S/T/S has been identified as a potentially effective response to recent calls for educational reform (Hurd, 1984).

From the perspective of the social studies education community, Patrick and Remy (1985, p. 2) have noted:

> "Decisions about science/technology/society issues often require 'tradeoffs' between conflicting values in which there is no clear view of right and wrong. Many environmental issues, for instance, force citizens to choose either clean air and water, or production and jobs. Most people agree that pollution by factories is bad; they also tend to agree that unemployment and a big drop in factory output are bad. At times, the problem has been to decide how to limit pollution enough to protect health and environment while still maintaining production and jobs. Making a decision in a conflict between economic and ecological values requires careful consideration of alternative factual and ethical claims. The eventual choice may result from a compromise between conflicting positions and values."

Although neither a universally accepted definition for environmental education nor a consensus concerning its appropriate focus exists, a substantive structure and framework have been identified, and a set of goal levels advanced (Hungerford, et al., 1980, pp. 42-47):

- ecological foundations;
- a conceptual awareness of issues and values;
- an investigation and evaluation of these issues; and
- training in and application of citizenship action skills.

Bogan (1973, pp. 1-3) characterized environmental education as the interdisciplinary process of inquiry into both the specific and the general environmental implications of human activities viewed from the perspective of social needs and values as they relate to society. This statement is particularly useful here, in that it clearly foreshadows today's S/T/S emphases. To some extent, the environmental education community serves as a common thread joining nature study, conservation education, and outdoor education, but it also has explicit and necessary interconnections with science and technology and the issues and problems of society (Disinger, 1986). It is generally accepted that the impetus for the synthesis which led to environmental education circa 1970 was increased concern for environmental quality (or, stated negatively, fear of severe deterioration of quality of life caused by reported and anticipated plummeting of environmental quality--viz., due to pollution and associated concerns). Thus, the rationale for initiating environmental education was in effect to refine and redirect the goals of those predecessors, as well as to fill an educational vacuum which was not being served by other entities, including, as they were then practiced, science education and social studies education--attention to the interrelationships between humans and environments.

Demonstrating that environmental education can be a positive, proactive approach to an educational consideration of environmental problems has been a major challenge, difficult to meet, and to date essentially unmet. The common perception is that environmental education focuses on what is wrong with science/technology/society interrelationships, rather than what is right (Disinger, 1986). Also, there is a continuing perception that technology can and will solve environmental problems--i.e., a "technology got us into these problems, and technology will get us out" attitude, which in its extreme form places unquestioning faith in the capabilities of the technological enterprise to resolve environmental problems, and in fact all problems, independently of the input of the natural and social sciences and especially independently of the layperson, educated or otherwise. That belief generally seems to decrease as educational levels increase (Silvernail, 1978), but it remains pervasive for many.

In a recent survey (Bybee and Mau, 1986), 262 science educators from 21 countries were asked to rank twelve global problems relating to science and technology. The top six in the rankings were:

- world hunger and food resources;
- population growth;
- air quality and atmosphere;
- water resources;

- war technology; and

- human health and disease.

Respondents also indicated that: 1) they expected science and technology-related global problems to be worse by the year 2000; 2) they, as science educators, were slightly to moderately knowledgeable about the problems; 3) they believe that it is important to study global problems in schools; 4) they detect a clear trend toward S/T/S in teaching and learning; 5) they believe that an integrated approach should be used to teach about environmental problems; and 6) there is public support for including global problems in school curricula.

An "Environmental Agenda for the Future" (Cahn, 1985) was recently developed as a result of a four-year study initiated by the chief executives of ten major environmental and conservation organizations--the Environmental Defense Fund, the Environmental Policy Institute, Friends of the Earth, The Izaak Walton League of America, National Audubon Society, National Parks and Conservation Association, National Wildlife Federation, Natural Resources Defense Council, Sierra Club, and The Wilderness Society. Though the report was not aimed directly at educators, the content and thrust of its report are of interest here. For example, the eleven topics around which its findings and recommendations are organized include: nuclear issues, human population growth, energy strategies, water resources, toxics and pollution control, wild living resources, private lands and agriculture, protected land systems, public lands, urban environments, and international responsibilities.

Yet another listing, produced by an international group of leaders from science, business, government, and environmental affairs at "The Global Possible" conference of the World Resources Institute (1984), reports these key concerns:

- loss of crop and grazing land due to desertification, erosion, conversion of land to non-farm uses, etc.;

- depletion of the world's tropical forests;

- mass extinction of species, principally from loss of habitat;

- rapid population growth;

- mismanagement and shortages of fresh water resources;

- overfishing, habitat destruction, and pollution in the marine environment;

- threats to human health from mismanagement of pesticides and hazardous substances and from pathogens in human wastes and aquatic vectors;

- climate change due to buildup of "greenhouse gases" in the atmosphere;

- acid rain and its associated effects; and

- mismanagement of energy fuels and pressures on energy sources.

The North American Association for Environmental Education (NAEE) has adopted a set of guiding principles which involve S/T/S rhetoric (NAEE, 1984, p. vi):

Environmental Education should-

- consider the environment in its totality--natural and built; biological and physical phenomena and their interrelations with social, economic, political, technological, cultural, historical, moral, and aesthetic aspects;

- integrate knowledge from the disciplines across the natural sciences, social sciences, and humanities;

- examine the scope and complexity of environmental problems and thus the need to develop critical thinking and problem-solving skills and the ability to synthesize data from many fields;

- develop awareness and understanding of global problems, issues, and interdependence, helping people to think globally and act locally;

- consider both short and long term futures on matters of local, national, regional and international importance;

- relate environmental knowledge, problem solving, values and sensitivity at every level;

- emphasize the role of values, morality, and ethics in shaping attitudes and actions affecting the environment;

- stress the need for active citizen participation in solving environmental problems and preventing new ones;

- enable learners to play a role in planning their learning experiences and providing an opportunity for making decisions and accepting their consequences; and

- be a life-long process--should begin at a preschool level, continue throughout formal elementary, secondary, and post-secondary levels, and utilize non-formal modes for all age and educational levels.

The similarities among the lists above are clear; allowing for differences in professional vocabularies and for some variance in specific interests, they are essentially the same. Thus, there is significant congruence of opinion as to what the problems are, and in fact what needs to be learned and taught relative to the interrelationships between and among science, technology, society--and environment.

In a practical sense, it is clear that S/T/S education, however defined and delimited, subsumes to a significant extent the content which environmental education was initiated to purvey, and in fact requires that content for substance. It has been argued that, if only for purposes of clarity, the inclusion of the term "environment" in the title of the S/T/S thus makes sense (Disinger, 1986; Lubbers, 1986)--S/T/S/E, S/S/T/E, S/E/T/S, for possible examples.

An ERIC search will locate many instructional materials of probable use to those seeking ideas for infusing these topics into school curricula. A number of such materials have been produced over the past several years, though not all of them use the current "buzz words." Among representative examples are:

- Hungerford, et al.'s (1978) "Investigation and Action Skills for Environmental Problem Solving;"

- Iozzi's (1982) "Preparing for Tomorrow's World" program, consisting of modules addressing moral/ethical dilemmas;

- A middle school program (Melcher, 1982) which includes lessons on applied technology topics;

- A social studies activities text (Melnick and Ronan, 1984) designed to provide high school students with various approaches for thinking about future resources;

- A set of five simulations for addressing science-related social issues in either science or social studies secondary classrooms (Parisi, 1986);

- A "Contemporary Issues in Science" program offering secondary teachers a case study approach to examining S/T/S related concerns (Staten Island Continuum of Education, 1982); and

- An exploration of the interactions of science and technology with society for middle school students (University of the State of New York, 1985).

There are a number of additional sets and sources of teaching materials useful in instruction at the interfaces of science/society/technology/environment, many of them commercial and thus not available through the ERIC system. This guide seeks to provide a sampling of the kinds of materials available, to encourage the practitioner concerning the availability and practicality of such activities, to provide leads to additional ones, and to suggest possibilities for local development of additional materials.

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NOTE: References to the activities contained in this volume begin on page 148.

ELEMENTARY SCHOOL

SCIENCE/SOCIETY/TECHNOLOGY/ENVIRONMENT ACTIVITIES

FUN AT THE SHORE

PURPOSE: To be able to express, orally or in writing, some of the uses and experiences possible in the beach environment and the importance of protecting these areas.

LEVEL: Elementary School

SUBJECTS: Science
Language Arts

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Options available to future generations must not be foreclosed.

REFERENCE: Richard C. Murphy. Wet and Wild: A Multidisciplinary Marine Education Teacher Guide, Grades K-6, Unit II, 1983, p. 15.

ACTIVITY: Have students collect pictures from magazines that relate to activities that one can do at the beach--sailing, swimming, fishing, picnicking, etc. Number the pictures.

Have each student choose three pictures that represent the activities he/she would most enjoy doing. Share the reasons for each of the choices in class.

DISCUSSION: Which picture was chosen the most times? What is it that appealed to so many? Did different people choose the same picture (i.e., the same environment) for the same reasons? For different reasons? How were choices affected by the activities they prefer to do? Can these activities be done anywhere else? What activities are special (limited) to the beaches? How can these beaches be protected for all to enjoy?

APPROPRIATE TECHNOLOGIES AND THE HOME

PURPOSE: To investigate how appropriate technologies are involved with resources used in the home.

LEVEL: Elementary School

SUBJECTS: Science
Social Studies

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

The distribution or location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

REFERENCE: Carol Wilson and Gary Krasnow. Science Study Skills Program: People, Energy, and Appropriate Technology, Student Text, 1983, pp. 7, 35, 13.

BACKGROUND: Anything which is appropriate fits the situation in which you use it. To see if something is appropriate, ask yourself:

Does it do the job and/or fit the situation?
Does it do too little or too much?
Is there anything that fits the situation better?

If it fits the job well, not by too little or too much, and if there nothing which fits the situation better, then it is appropriate.

The environment is the land, water, and living things in a particular area. A technology is most appropriate when it does not hurt or change the environment.

Four criteria for judging whether or not a technology is appropriate in its effects on the environment are:

1. The technology has little short or long term effect on living things.

2. The technology does not make the environment smell or look unpleasant.

3. The environment can recover from the technology quickly.

4. The technology does not produce a lot of waste material.

ACTIVITY: Below is a list of resources you use at home. We can get and dispose of these resources using technologies which are appropriate or inappropriate.

To the left of this list are spaces where you can check off where the resource comes from. To the right of the list, you can check off where you dispose, or get rid of, each resource.

Complete as much of this chart as you can, checking off where each resource comes from and how you dispose of it. You may need to ask your parents for help. You can also check package labels to find out where a resource comes from.

Do the best you can. If you do not use one of the resources listed in your home, or can't find out about where it comes from or how you dispose of it, leave that part of the chart blank.

DISCUSSION: What technologies are involved in getting and disposing of these resources? What are the environmental consequences, in each case?

HOME RESOURCE USE CHECKLIST

WHERE RESOURCE IS PRODUCED					WHERE YOU DISPOSE OF RESOURCE			
Locally	In Your State	In United States	In Another Country	RESOURCE USED AT HOME	Dump	Sewer	Burn	Recycle
				Eggs				
				Meat				
				Bread				
				Dairy products				
				Fruits/vegetables				
				Plastic bottles				
				Glass bottles				
				Aluminum cans				
				Newspaper				
				Fertilizer				
				Water				
				Electricity				
				Gasoline				
				Oil				
				Coal				
				Natural gas/propane				
				Solar energy				

CONSEQUENCES OF ENERGY PRODUCTION, DISTRIBUTION, AND USE

PURPOSE: To compare the use of energy in children's lifestyles at the turn of the century with the energy usage of today's youth, and to suggest the relationships between the use of energy and quality of the environment.

LEVEL: Elementary School

SUBJECTS: Science
Social Studies

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: Michael J. Caduto, A Guide for Environmental Values Education, 1985, Exercise 4.

ACTIVITY: Ask students to interview someone who is old enough to remember what life was like before the days of great usage of oil and natural gas. (A grandparent or elderly neighbor will likely be very pleased to be asked.) Ask questions such as those below and others that individual students can think of. Ask students to record responses for subsequent reporting and class discussion.

As final questions, ask the person being interviewed to indicate how he or she finds life more enjoyable now as a result of much greater use of energy. In what ways does he or she like the "good old days" better?

After the interviews, divide your class into two groups, asking one group to make a mural of "Yesteryouth" and the other group to construct a mural depicting the lifestyle of today's youth. Each child should be responsible for one item (i.e., a form of recreation, toy, game, or family fun) and a paragraph describing his/her choice.

INTERVIEW QUESTIONS

1. What kind of lights did you use in your home? _____
   How was it heated? _____

2. What fabrics were clothes made of? _____
   Was clothing harder or easier to take care of? _____

3. What sort of washing machine did you have? _____

4. What kind of stove (and what kind of fuel) did your family use for cooking? _____

5. How did you keep your food fresh? _____

6. How was food packaged when it came from the store? _____
What did milk come in? _____

7. What sort of soap did you use? _____ Did it clean as well as the cleaners we have now? _____

8. How was your water heated for bathing and laundry? _____

9. Did your family have a car? _____ If not, how did you travel? _____

10. Did you have a radio? _____ What did it look like? _____ Did you go to the movies? _____

11. What kinds of entertainment did you enjoy? _____

12. What were some of your favorite games and toys? _____
What kind of family recreation did you enjoy? _____

DISCUSSION:

1. When the murals are completed, discuss the kinds of energy used by both groups of people. Who used the most energy in their everyday lives--yesterday's youth or today's? Is energy important for human well-being?

2. What impacts might a greater use of energy have on the world environment? What could you give up to save energy?

3. What do you believe would be an "ideal mix" of old and new lifestyles as far as the use of energy is concerned? (Can be a writing assignment.)

4. What changes are likely in the coming years?

LIFE STYLES

PURPOSE: To suggest that lifestyles are related to natural resource usage.

LEVEL: Elementary School

SUBJECTS: Mathematics
Social Studies

CONCEPT: Sociological and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: Mary Lynne Bowman, Values Activities in Environmental Education, 1979, p. 37.

BACKGROUND: The average person in the United States uses 100 gallons of water per day. The average person in Great Britain uses 50 gallons of water per day. The average person in a developing country uses 5 gallons of water per day.

ACTIVITY:

Discussion questions-

1. How much more water does a person from the United States use than a person in Great Britain?
2. How much more water does a person from the United States use than a person in a developing country?
3. What might account for these differences?
4. What do these differences say about the ways people live in these different countries?
5. What do these differences say about the availability of water in these different countries?
6. Do you think that a person in a developing country would prefer to live the way a person in the United States lives? Why or why not?
7. What would happen if everyone in the world used the amount of water per day that the average person in the United States uses?

ADAPTING TO NEW ENVIRONMENTS

PURPOSE: To identify "new resources" and considered how they may be properly developed.

LEVEL: Elementary School

SUBJECTS: Science
Social Studies

CONCEPTS: Environmental management involves the application of knowledge from many different disciplines.

The distribution and location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

REFERENCE: Milton R. Payne. Using the Outdoors to Teach Science, 1985, pp. 44-45.

BACKGROUND: Tell the children that the class has just landed upon a distant planet. The planet has an atmosphere similar to that of earth. The proportions of the planet are quite different, however, from those on earth. The magnitude of everything on plant "Hugeo" is such that everything appears to be hundreds of times larger than what we are used to on earth. Thus, we are the size of ants in comparison to the plants and animals of "Hugeo."

As the "pioneers" of the planet, we will have the right to settle a large area of the planet. To settle the planet, we are grouped in families of three or four.

ACTIVITY: Our task is to locate our claim and do a survey of what is contained in the area given to us. We are to describe the type of soil present as well as the composition of the soil, rocks, plant, and animal life. Is the area desert-like, or is it covered with trees? In our report we should also describe the probable needs we will have before we can inhabit our 113-unit tract of land. How will we need to modify the area in order that it can more easily support us?

Tell the students that they are about to leave the spaceship (classroom) and go out onto the surface of "Hugeo" (the school grounds). In a "family" of three, they are to identify their 113-unit homestead by tossing a paper plate through the air. Wherever it falls, the area underneath the plate is their new "home." Outline the edge of the plate with 10 popsicle or craft sticks. This is "fence." Use string or yarn for wire if you wish to complete the "fence."

Each family needs a recorder to make notes. First the family describes the general nature of the homestead using the magnifying lenses. Is it barren, rocky, full of trees, diversified, or on a slope?

The family should then collect some of the soil and examine it carefully. They should describe the soil: Does it appear to be fertile? Is it sandy? Closely packed? Rocky? They should dig down into the soil several inches. Does the soil change? How? What kind of plants and animals are present? Look closely. Do they appear dangerous? Are they possible food sources? Describe them. How many different kinds are on that particular homestead?

What other things are found on the land? What will the family need to do to make the land fit to live on? Will it farm the land or raise cattle? Where will the cabin be located? Why was this location chosen? What technologies are needed to establish homes and activities? Must they be imported, or can they be developed on "Hugeo?"

Once students have completed "exploring" and recording data, each "family" should now show the other "families" their homestead. The recorder for each group should explain all findings and tell what they hope to do with the land. You should encourage comments, questions, and ideas from the class as they move from homestead to homestead.

Discuss the variety of life found in each area. What was found in the soil? Were there both plant and animal life on each plot? Were the plans to modify the plots feasible? Would man and his proposed technologies have a negative effect on the environment of each area? A positive effect? What could we do to preserve the planet "Hugeo" in as natural a state as possible and yet make it habitable for man?

Finally, ask the students why the activity is called the "113-Unit Homestead." (Hint: consider the paper plate and use πr^2.)

TECHNOLOGY AND WILDLIFE CONFLICTS

PURPOSE: To become acquainted with wildlife habitat problems caused by technological developments.

LEVEL: Elementary School

SUBJECT: Science

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

The distribution and location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

REFERENCE: Fish and Wildlife Service, U.S. Department of the Interior. Wildlife Conflicts? Issue Pac, Leader Overview, 1984, p. 2.

BACKGROUND: Many technological developments have caused wildlife conflicts. Airports, hydroelectric power plants, and utility structures provide attractive habitats for a number of wildlife species.

Frequently, airports are built near water or wetlands. Gulls, blackbirds, and starlings occasionally fly across runways to reach nesting and feeding sites. Sometimes they collide with aircraft or are sucked into plane engines. In 1976, there were 788 bird strikes on aircraft in the United States, causing $10 million in property loss and $500,000 in lost revenues.

A variety of birds roost on electric power lines and can cause power interruptions. By coiling in transformers, snakes can cause power outages, and squirrels do likewise when they chew insulation on lines. Woodpeckers are attracted to utility poles and have made necessary replacement of many telephone poles. The operation of water cooling and intake systems have been interfered with by aquatic plant growth, beaver dams, and by the presence of jellyfish, alewives, and clams. In 1978, Commonwealth Edison of New York reported that wildlife caused 1222 electrical service interruptions.

ACTIVITY: The above are examples of situations where wildlife and technologies come into conflict; the perspective of these examples is from the human side--that is, these are problems created by wildlife, or situations in which wildlife interfere with human activities.

For discussion purposes:

1. What statements might one make, looking at these same situations from a wildlife perspective?

2. Considering both the human and the wildlife perspective, what are possible resolutions to these problems? Develop a list of several, and attempt to arrive at a prioritized list of solutions which will be "the best possible" for both humans and wildlife.

3. Using current newspaper and magazine articles (particularly including publications such as Audubon, National Wildlife, International Wildlife, Defenders of Wildlife, and others), find other examples of similar situations.

EXPLOIT OR RECYCLE?

PURPOSE: To help learners understand how a technology may convert a "waste" material into a resource, with a positive environmental impact.

LEVEL: Elementary School

SUBJECTS: Science
Social Studies
Mathematics

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Natural resources are interdependent, and the use or misuse of one will affect others.

REFERENCE: Charles E. Roth and Linda G. Lockwood, Strategies and Activities for Using Local Communities as Environmental Education Sites, 1979, pp. 103-104.

BACKGROUND: Prepare fact sheets, which should contain the following statements:

1. There are 52 weeks in the year.
2. It takes about 30 years for a pine seedling to reach pulpwood size in prime pulpwood country.
3. One acre of land can grow about 500 trees.
4. The (name of your local paper) generally weighs about ounces. Its Sunday edition weighs _____ ounces.
5. It takes about 17 trees to make one ton of newsprint.
6. The current price for recycled paper in our area is _____ per pound.

ACTIVITY:
1. Count the newspapers used in the home for one week. Using the weight of an average newspaper, determine the weight of the newspapers each family uses in a year.
2. Have the group share their findings and determine how much newspaper is used by all the families of the group in a year. What is the average use per family per year?
3. Multiply the figure found in the last question by the number of families in your town (see Town Report or inquire of local officials) to determine approximate newspaper consumption in the town or city.

4. Using the information gathered and the fact sheet, work out answers to the following questions:

   - Approximately how many trees were used by the group's families to meet their newspaper demand this year?
   - How many for the town or city's needs?
   - How many acres does it take to grow the trees needed for these newspapers?
   - How long did it take to grow them?
   - How long before there will be replacements for these trees?

5. Have the learners list what happens to old newspapers in their homes. What happens to the bulk of papers?

   - If all the used newspapers were collected for recycling, how much would it be worth?
   - How would this affect the amount of land needed for producing paper pulp?

6. Find out who in your community recycles old newspaper. Interview the people in charge. How much paper do they collect each year? Based on your figures, what percent of local paper gets recycled? Can you figure ways to get more people to recycle their newspapers? If more people recycle their paper, what happens to the price per pound (or ton) that the recycler will receive?

INTERNATIONAL TRADE IN ENERGY

PURPOSE: To identify the complexities of international trade in energy-producing natural resources.

LEVEL: Elementary School

SUBJECTS: Mathematics
Social Studies

CONCEPTS: A variety of institutional structures is involved in planning and managing the environment.

Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCES: American Petroleum Institute. Energy in America: Progress and Potential, 1981; Lester R. Brown and others, State of the World 1986, pp. 78-81.

BACKGROUND: Demands for energy by industrialized countries have increased as technologies have expanded, though in recent years there have been decreases by these nations in oil consumption. The table below summarizes world oil consumption, by region, in 1973, 1979, and 1984.

World Oil Consumption, by Region, 1973, 1979, and 1984

Region	1973	1979	1984
	(million barrels per day)		
North America	18.6	19.8	16.6
Western Europe	15.2	15.0	12.3
Japan	5.5	5.5	4.6
Europe and Soviet Union	8.4	11.1	11.4
Latin America	3.4	4.2	4.5
Other Asia/Oceania	3.9	5.6	5.8
Middle East	1.2	1.5	1.9
Africa	1.0	1.4	1.7
Total[1]	57.1	64.1	58.9

[1]Numbers may not add to totals due to rounding.

Source: British Petroleum Company, BP Statistical Review of World Energy (London: 1985).

ACTIVITY: The following questions, and related ones, may serve as the basis for further research and discussion:

1. Why have the industrialized regions cut back on their consumption of oil? What have been the percentage decreases between 1979 and 1984?

2. Why have the other regions increased their consumption of oil? What have been the percentage increases between 1979 and 1984?

3. Does the action of the industrialized regions suggest a recognition of the need for conservation of scarce resources, or are there other causes for their action?

4. Do the other regions have the same objectives as the industrialized regions? Why, or why not?

DISPOSING OF PLASTICS

PURPOSE: To investigate the use of plastic for household items and the environmental problems associated with discarding them.

LEVEL: Elementary School

SUBJECTS: Science
Social Studies
Language Arts

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Management is the result of technical and scientific knowledge being applied in a rational direction to achieve a particular objective.

REFERENCE: Lori D. Mann and William B. Stapp, Thinking Globally and Acting Locally: Environmental Education Teaching Activities, 1982, p. 107.

ACTIVITY: Save all the plastic your family discards in a one or two week period.

Calculate the average weight of plastic that each member of your family discards in a year. At that rate, what is the total weight of plastic that is discarded by all the people in your community in a year?

What particular problems are encountered in disposing of plastic by composting it or burying it in a landfill area?

Burn three or four small, thin pieces of different kinds of plastic. Do you think that incineration is a good way of getting rid of used plastic? Why?

What do you think can be done about the plastic pollution problem?

List all the things you use that are made of plastic.

How many of these items do you really need? Would you be willing to do without them?

For which items could you use other things not made of plastic?

DISCUSSION: 1. What environmentally and politically significant world resource is tied to the production and use of plastic? (How is plastic made?) Is the amount of plastic used by one person important to the world environment? Why or why not?

2. From the list of items you use that are made of plastic, design a written contract stating actions that you agree to take in order to reduce your use of plastic and thus improve the quality of the world environment. Put the contract into practice for one month. After that time, evaluate your performance and decide whether or not you will continue with your contract on a voluntary basis. Why or why not?

HOW MANY FISH CAN WE TAKE FROM THE SEA?

PURPOSE: To learn that there must be limits on what can be taken from the sea, or from any environment, if we are to protect any resource and ensure its perpetuation in time.

LEVEL: Elementary School

SUBJECTS: Social Studies
Science

CONCEPTS: Options available to future generations must not be foreclosed.

Natural resources are interdependent, and the use or misuse of one will affect others.

REFERENCE: Richard C. Murphy, Wet and Wild: A Multidisciplinary Marine Education Teacher Guide, Grades K-6, Unit II, 1983, pp. 21-22.

BACKGROUND: There is a maximum number of fish that can be taken from any region. If we take more than this amount, there will be fewer parent fish to create young. With fewer young, the population declines and the fishery will be lost.

ACTIVITY: Cut some paper into fish shapes so that each child is given 14 (4 parents and 10 babies). Color the parent fish yellow and the babies blue.

How many of you like to go fishing? Each of you will have 14 fish (4 parents and 10 babies). You will have five minutes to trade fish with each other. The parent fish are more valuable than the babies because they will produce more fish for us to eat. Each of the parents is worth three babies. At the end of five minutes, the one with the most number of equivalent fish (parents and babies counted together) will win as long as he/she has at least two parent fish in his/her group.

Who is the winner? Why must you have at least two parent fish?

Pretend that each of you owns a lake and these are the fish in your lake; whose lake would you like to go fishing in?

Why would you not want to go fishing in _____'s lake?

Would it have helped if he/she had put a limit on the number of fish you could take from his/her lake?

Would he/she then have had fish for the next year?

Do you think people should be allowed to catch as many fish as they want, even if there is none left for others in the future?

Do you think there should be laws to protect fish?

What kinds of laws would you write?

Suggestions:

This game could be divided into sections. Let the children trade indiscriminately with no rules. Then stop them and tell them they must have at least two parents to win. Then start the game again and continue under new rule. (Those that were selfish and got lots of fish but no parents will now have to "deal" with the others.)

WHO OWNS THE NON-LIVING RESOURCES?

PURPOSE: To become aware of the complexities involved in ownership of the resources taken from the ocean.

LEVEL: Elementary School

SUBJECT: Social Studies

CONCEPTS: A variety of institutional structures is involved in planning and managing the environment.

The distribution and location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

REFERENCE: Richard C. Murphy, Wet and Wild: A Multidisciplinary Marine Education Teacher Guide, Grades K-6, Unit II, 1983, pp. 25-26.

ACTIVITY: Using 3 x 5 cards, have the class compose predicaments in which a landlocked country (and also a coastal country) might find itself. Write each predicament on a separate card. Try to write enough so that every student will have one. Some examples are listed on the following page.

Place the cards representing coastal countries on desks situated around the edge of the room. Place the landlocked countries on the remaining desks.

Students take their seats and each represents the country and predicament on the card that is on his/her desk. Each student, in turn, reads the predicament and gives a possible solution. Discussion will follow each presentation until a possible consensus is reached.

At the end (after the students "give and take" with each other), write out the acceptable agreement and have each student (country) sign. Using current newspaper clippings, etc., discuss how this game relates to happenings in everyday life.

DISCUSSION: How does this game relate to the real world? Do decisions like these really have to be made? What would better prepare you to make these important decisions for your country? Does the sea belong to everyone or no one? Can someone possess exclusive rights or claims to any area? (No.) How would you be able to stake your claim? Who may exploit the area? Should there be production controls? If so, who would set the limits? How would you decide what the limits would be? What would this do to the "freedom of the seas" concept?

Examples of Predicaments:

1. You have access to manganese nodules but only your neighbor has the present technology to extract them.

2. According to your calculations, you have a strong indication that there is a valuable "find" a few miles past your boundaries. What do you do? Tell your neighbor? Sneak it out? Work out a deal?

3. Your equipment for exploration is rudimentary. Your neighbor offers assistance for a percentage of the profits. How much would you agree to, if any at all?

4. You're a large, prosperous, coastal country with ever-increasing energy needs. Convince your poor, landlocked neighbor that you should get more energy.

5. You have the technology to extract valuable ores from the sea but only your coastal neighbor has access.

6. You've discovered oil by slant drilling from land, but you discover that it's on your coastal neighbor's property.

7. You are a poor landlocked country. Convince the more wealthy countries that you should be given an EQUAL share of the resources they exploit, since the ocean is to be used for "all nations."

ENERGY AND TRANSPORTATION

PURPOSE: To organize and analyze data relevant to automobile use in the community, and to explore ways in which alternative uses of motor vehicles could improve environmental quality.

LEVEL: Elementary School

SUBJECT: Social Studies

CONCEPT: Management is the result of technical and scientific knowledge being applied in a rational direction to achieve a particular objective.

REFERENCE: Michael J. Caduto, A Guide for Environmental Values Education, 1985, pp. 54-55.

ACTIVITY:

1. Divide the class into four teams. Tabulate the size and number of cars, buses, motorized bicycles passing corners of the school and the number of people in each vehicle. Each team will work in groups of two--one will observe and count, the other will record. These pairs will record data as small cars, large cars and buses and the number of passengers in each. All teams use the same code: S 1 (small car and driver only), S 3 (small car, driver and two passengers), L 2 (large car and two people), B L (bus light load), B F (bus full load), etc.

2. For more accuracy, different times of the day should be used and several days ought to be used for sampling.

3. The whole class should have a briefing session before the tabulating is done so that all are in agreement on code used and how to judge the fullness of bus and size of car.

4. When teams return they will record their data on nine different sheets.

   Example:
   a. Friday 8:30-8:50 a.m.
   b. Friday 10:45-11:10 a.m.
   c. Friday 12:30-12:50 p.m.
   d. Monday 8:30-8:50 a.m.
   e. Monday 10:45-11:10 a.m.
   f. Monday 12:30-12:50 p.m.
   g. Tuesday 8:30-8:50 a.m.
   h. Tuesday 10:45-11:10 a.m.
   i. Tuesday 12:30-12:50 p.m.

5. On the day that organizing data is to be done, form the class into nine groups. Each group will take one master sheet of

data and organize it by counting each classification. Example: S 1; S 2 or 3; S 4 or more; L 1; L 2 or 3; L 4 or more; B L; B M; B F. Total of tabulations should equal total of cars listed. When each group finishes the count and checks, the tallies can be put on squared paper and some totals can be figured.

DISCUSSION:

1. Can you form any conclusions about how people are using motor vehicles?

2. Can you suggest some ways we can use automobiles and buses to economize or save gasoline?

3. Did you have any difficulty with the collecting of data? If so, can you suggest how the method can be improved?

4. Did you meet with any reactions from people as you collected your data?

5. How do the results from your community compare with the results from a community in another country? In which community are motor vehicles used most wisely? Which country would have least environmental problems associated with motor vehicle use?

ACTIVITY 2: Present the following moral dilemma to the learners:
Due to the air pollution and traffic congestion caused by the abundance of gasoline powered vehicles, the government is going to issue a policy to restrict their use. One of the policies they are considering is to increase the distance from school that children must live to ride the bus. About one third of the children now riding the bus will have to begin walking to school within one month if the policy is passed. Children will be asked to vote "yes" or "no" on the new rule.

DISCUSSION:

1. What are the issues to be considered?

2. How will the rule affect the children?

3. What benefits may result from the new rule? What are its drawbacks? Alternatives?

4. Weigh the consequences of each stand, and hold a straw poll of the class. Or the children can present an alternative plan.

PETROLEUM POTPOURRI

PURPOSE: To describe how petroleum is being consumed, leading to dwindling world reserves.

LEVEL: Elementary School

SUBJECTS: Science
Social Studies

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: Iowa Department of Education. Energy Conservation Activities for the Elementary Grades, 1986, Activity I-6. Activity developed by Duane Toomsen.

ACTIVITY 1: The student should have a basic understanding of petroleum-based products before attempting this activity. Each student is given a copy of the story "Pete and Petroleum." The students underline each item or activity in the story which somehow relies on petroleum. (Ex: underline alarm [clock] because the clock is probably made of plastic, a petroleum product.) One student reads aloud. Another student is designated as the dipper, and the rest of the students follow the script, call out the word "dip" when a petroleum product is mentioned. Students are to underline the petroleum product. Discussion may follow regarding certain items considered petroleum products. The designated dipper in each instance dips out a cupful of "petroleum," and throws it away (down the drain) so that the students see petroleum consumption leading to diminished reserves.

ACTIVITY 2: A petroleum relay race is played. The students are divided into teams, each team representing a different country. The teacher sets a bucket of water at the front of the room to represent the world's supply of petroleum. The object of the game is for each "country" to collect as much petroleum as time permits, relay fashion. The teacher gives each team a collecting cup and a bucket to hold all the collected petroleum. On the "go" signal, a member from each team 1) runs to the petroleum pot, 2) dips out a cupful of petroleum, and 3) carries it back carefully (without spilling a single drop of this precious commodity). This process continues with each succeeding team member until the petroleum supply is depleted. The disequilibrating factor is that each country is given a different-sized cup:

U.S.A.	2-cup container	Mexico	1/4 cup container
France	2/3 cup container	China	1 Tablespoon
U.S.S.R.	1/2 cup container	Kenya	1 Thimble

[Each cup represents the proportional amount of petroleum consumed by that country.]

The students then discuss possible reasons why the USA consumes so much more energy (petroleum) than the other countries. They make a list of ways Americans use petroleum.

ACTIVITY 3: Students read or interview someone knowledgeable about lifestyles in other countries. Comparisons of lifestyles are made. Implications are made as to how Americans could conserve petroleum if they were to assimilate some of the customs, habits, and values of those other countries. What alternatives to petroleum-based products are there? What actions could Americans take to conserve petroleum?

ACTIVITY 4: The U.S.A. represents 6% of the population and consumes 34% of the world's energy.

The U.S.A. consumes:

2 1/2 times as much energy as the USSR
3 times as much energy as France
4 times as much energy as Japan
10 times as much energy as Mexico
23 times as much energy as China
100 times as much energy as Kenya

Another way to show this is to hand out peanut M & M's in clear plastic glasses, so that students can see concrete examples of energy consumption among the continents of the world. Students could represent the population of the various continents. The world consumes 80 quadrillion Btu's of energy annually. We can state this as 80 quads, and each M & M may represent 1 quad for a total of 80 M & M's. The class is divided proportionately allocating student numbers by continent population.

Country	Population	NRG Alloc. of M & M's
North America	8%	39% - 32 M & M's
South America	6%	8% - 6 M & M's
Africa	10.5%	8% - 6 M & M's
Asia	61%	18% - 14 M & M's
Europe	14%	24% - 20 M & M's
Australia/Oceania	.5%	3% - 2 M & M's

PETE AND PETROLEUM

The day Pete had been waiting for had finally come! He jumped out of bed as soon as his alarm went off. The cold floor on his feet sent Pete to the thermostat. Ah! There! He heard the furnace click on. Now for a nice hot bath. He needed to listen for the weather report, so he turned on the T.V. for the early morning report. A little music from KMZT radio was next. As he lay back in the hot water, Pete dreamed of the trophy he hoped to win. He made a place for it in his mind on the shelf over his stereo components. But he had lots to do yet before he would win that race! He wanted to look his best so he must shave and blow comb his hair. Where were his disposable razors? Oh, yes! They were still in the plastic bag in the car....along with his shaving cream. Over the air came the report...the weather sounded great! Pete remembered he had to pack a lunch for two. He got out the package of bread, the sandwich bags, and the package of bologna, a couple of styrofoam cups and the thermos for hot chocolate. Into the microwave went a cup for now. As he brushed his teeth, put on his deodorant and cologne, and combed his hair, he planned his agenda. He had to put on his new vinyl seat covers and floor mats in his car. He needed to check the oil and fill up before picking up Joe. He would use the phone at the station as his tires were being checked to call Joe to remind him to put new film in his camera. Pete put on his wind-breaker over his good luck shirt. His sunglasses and goggles were on his hat and on went his blue-striped tennis shoes. He was on his way...he knew it would be a winning day!

List all the petroleum products from the story.

Petroleum Products

Ink
Heart valves
Parachutes
Stretch pants
Telephones
Brassieres
Enamel
Transparent tape
Antiseptics
Vacuum bottles
Ping-pong paddles
Purses
Planters
Deodorant
Air conditioners
Crayons
Dolls
Bubble gum
Floor polish
Sports car bodies
Tennis balls
Tires
Carpet sweepers
Shower doors
Soap dishes
Slip covers
Shoes
Volleyballs
Tobacco pouches
Refrigerator linings
Electrician's tape
Model cars
Folding doors
Floor wax
Mascara
Sweaters
Sneakers
Electric blankets
Tennis rackets
Drinking cups
Housepaint
Rollerskate wheels
Hair dryers
Guitar strings
Ammonia
Eyeglasses
Digital clocks
Life jackets
TV cabinets

Car battery cases
Insect repellent
Ice buckets
Fertilizers
Hair coloring
Toilet seats
Denture adhesives
Frisbees
Loudspeakers

OPERATION PIPELINE

PURPOSE: To describe the sequence of events from natural gas production to the delivery to the home, learning where the community gets its natural gas and considering the effects on the environment.

LEVEL: Elementary School

SUBJECT: Science

CONCEPT: The distribution and location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

REFERENCE: Iowa Department of Education. Energy Conservation Activities for the Elementary Grades, 1986, Activity 1-8. Activity developed by Janey Swartz.

BACKGROUND: Natural gas is not the same as gasoline. It is a gas formed by the natural decomposition (mostly by bacteria) of animal tissue and plant fiber. This decomposition took place millions of years ago (although it is still taking place today) and the gas has been trapped underground since then. We are using the natural gas much faster than it is being produced by natural processes today.

Many power plants burn natural gas for electricity production. It is a clean-burning, efficient fuel. However, supplies are limited. Some say that there is only enough to last 20-35 years at our present rate of consumption.

Of the total energy used in homes, 70% is used for heating and cooling the home. 20% is used to heat water and 10% is for other electrical needs (cooking, lights, small appliances, etc.) So, if we conserve energy in these areas, we will be conserving natural gas.

ACTIVITY 1: The students "become" the various components of the natural gas distributing system. Two children from the drilling rig, four or five more join hands to become the pipeline, carrying natural gas to the power plant. Four children become the trees in the forest which need to be chopped down so the pipeline can go through. The three children forming the power plant make electricity using the natural gas as fuel. Four more children become electric lines "zapping" electrical current to the house (2 or more children). One child becomes the radio in the house, another becomes the pot of water. The teacher directs the floor plan. The students pose as the various components. They also create the sound effects. The teacher will establish the order of events from drill site to the teakettle. When the pot of water boils and the radio broadcasts a weather report, the chain of events has been completed.

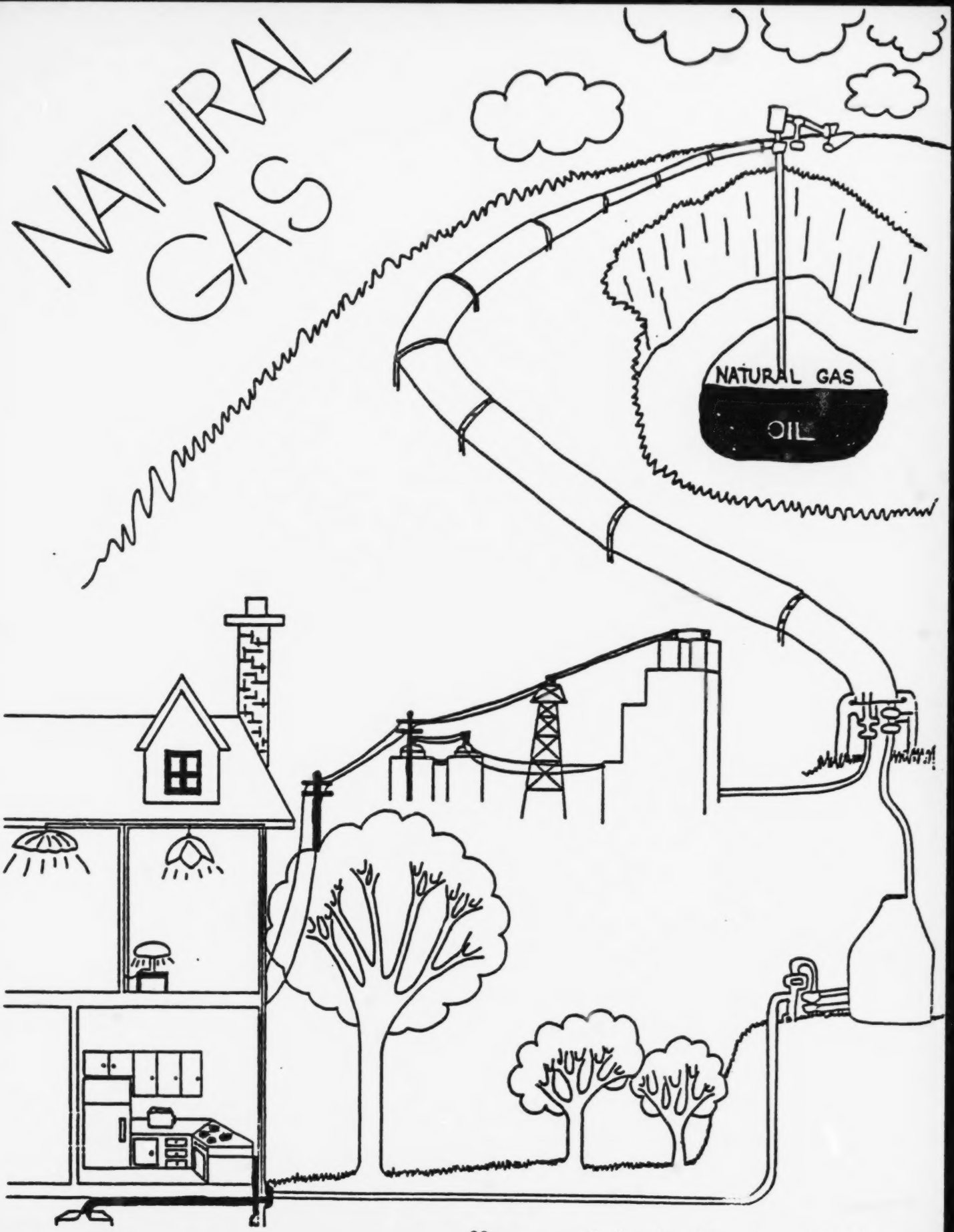
1.	Drilling rig	2 students	holding hands and pump up and down-making pumping sucking sounds
2.	Pipeline	4-5 students	connect hands - "swish swish" sound
3.	Trees	4 students	outstretch and connect arms (fall when "chopped down" for the pipelines to come through)
4.	Power plant	3-5 students	make electricity (turbines could spin around)
5.	Electric wires	4 students	connect hands and "zap-zap" electrical current
6.	Pot of water	1 student	boils and makes "bubble-bubble" sounds when the electricity reaches it.
7.	Radio	1 student	broadcasts a weather report when the electricity arrives

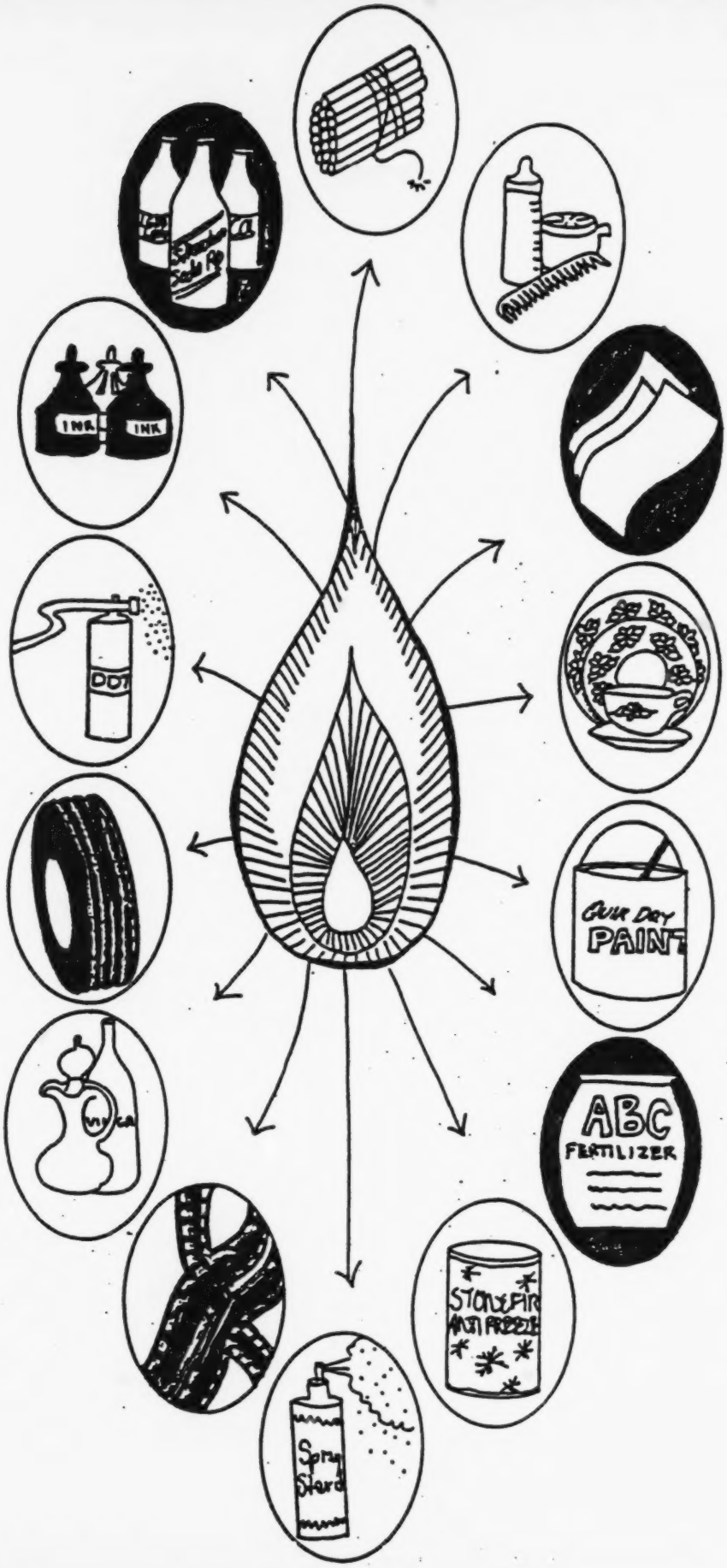
ACTIVITY 2: The students color and verbalize the chain of events from drilling rig to radio (Diagram, p. 32). Notice there is a direct pipeline to the house for the gas stove and furnace. (The teacher should point out the fact that some stoves and furnaces use natural gas.)

ACTIVITY 3: A resource person from the utility company is invited to talk about the community's source of natural gas, location of pipelines, construction of pipelines, etc. Maps would be helpful to show natural gas sources and pipelines.

ACTIVITY 4: The diagram on page 33 illustrates some of the products made from, or by use of, natural gas. Investigate the role of natural gas in the production of these materials.

NATURAL GAS




INK
INK
DDT
QUIK DRY
PAINT
ABC
FERTILIZER

ELECTRICAL LIFESTYLE

PURPOSE: To examine the extent to which students use electricity in their daily lives, and to compare different lifestyles contrasting the energy consumption of each.

LEVEL: Elementary School

SUBJECTS: Science
Social Studies

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: Iowa Department of Education. Energy Conservation Activities for the Elementary Grades; 1986, Activity I-13. Activity by Sindy Styles.

ACTIVITY 1: The students review the items they own and use in their homes. (See page 36). Then they write the names of electrical appliances they consider most important to them on the electrical outlets. (See page 37). The families help may need to be solicited. An "N" for necessity and "L" for luxury is lettered under each item.

ACTIVITY 2: The teacher calls on one student to name off the items on his/her list. If anyone else has any new items, those are added and so on until every student has his/her items appearing on the one class list. Each student is given a blank chart. (See page 38). Each item is voted either a luxury or a necessity by a show of hands. The student then organizes a way to show the class's top 10 luxuries and top 10 necessities. (Charts, pictures, diagrams, etc.) The teacher may want to group the students for this project instead of having the students work individually.

ACTIVITY 3: The student considers eliminating three luxury items and two necessities in order to conserve energy. A "fast" for a week is experienced and at the end of the week, the student expresses his feelings about the new "lifestyle" experienced. The items which are eliminated for a week could be brought to school and placed on a table to symbolize the sacrifices being made by the students. What alternatives or substitutions were made? Would he/she be able to comfortably continue without these items?

ACTIVITY 4: The students hold an all-school, no (or low) electricity day. Little or no electricity should be used. (Lights, duplicated materials, audiovisual equipment, bells, food preparation, etc., would all be affected. A sort of a return to "Little House on the Prairie" days would be enacted). Students may want to go a step farther and see how they can function without using electricity at home as well. (Toaster, oven, hair stylers,

radio, T.V. lights, hot water, etc., would all have to be sacrificed). Obviously, the cooperation and support of the school administration and the family would be a necessity.

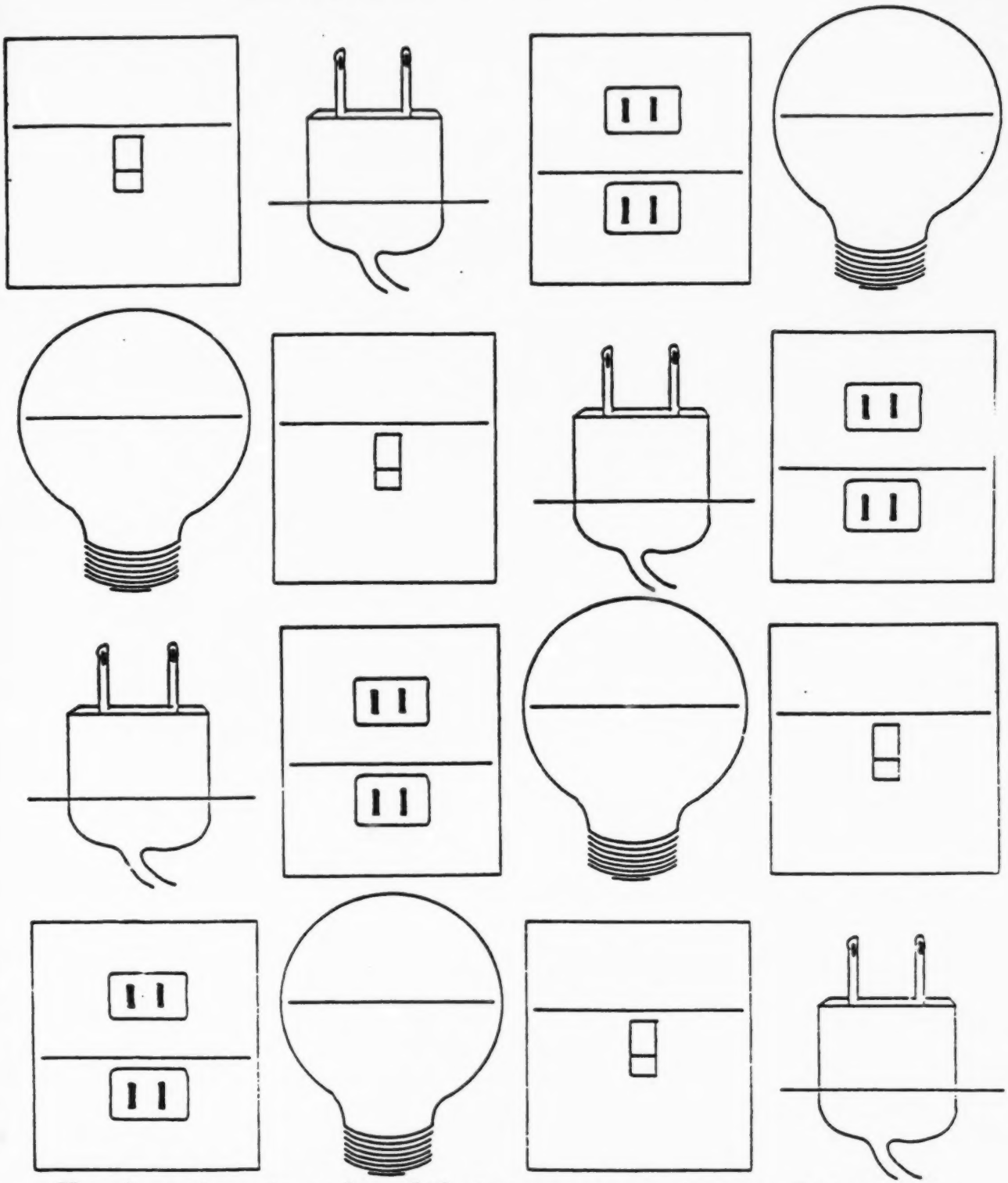
ACTIVITY 5: Modern living would be difficult without electrical energy. Many of the conveniences we enjoy today would be impossible without electricity. Of the total energy used in homes, 70% is used for heating and cooling, 20% is used for heating water and 10% is for lights, cooking and small appliances. Illustration "Can You Guess?" compares the energy consumption of some common household items (See 39).

MY ELECTRICAL LIFESTYLE

Check each item you have in your home. Double check items you use yourself.

___air conditioner
___food blender
___dehumidifier
___humidifier
___dishwasher
___door bell
___back massager
___electric blanket
___can opener
___clock
___coffee maker
___slide projector
___iron
___electric saw
___drill sander
___television
___washing machine
___bun warmer
___floor polisher
___hair curler
___clothes dryer
___electric fan
___space heater
___lamps
___sandwich grill
___electric knife
___refrigerator
___tank filter
___aquarium
___hedge cutter
___electric typewriter
___home movie
___vacuum cleaner
___radio
___garage door
___warming tray
___water softener
___snow blower
___orange squeezer
___pencil sharpener
___electric stove
___waffle iron
___toaster
___musical instrument
___griddle
___frying pan
___electric oven
___electric shaver
___rug shampooer
___shoe polisher
___VCR
___movie projector
___tape recorder
___electric toothbrush
___electric mixer
___hair dryer
___record player

Energy Eaters in my Home

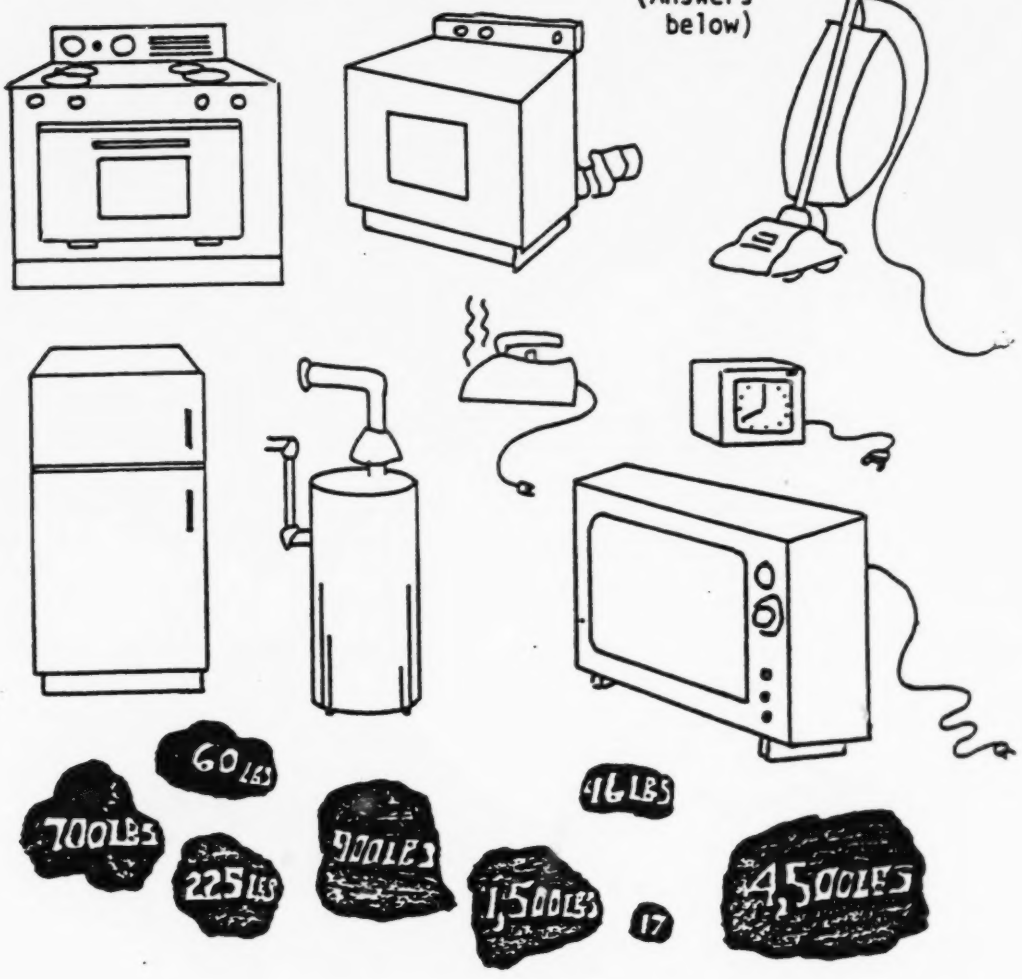


Number them in order of their importance to you. Put an "N" under each item which is necessary for living. Put an "L" under each item which you could live without (luxury).

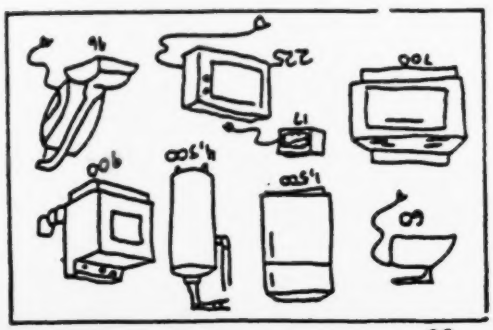
LUXURY	or	NECESSITY
How many say "Yes, it is a luxury."	NAME OF ITEM	How many say "Yes, it is a necessity."

CAN YOU GUESS ?

HOW MANY POUNDS OF COAL ARE USED ANNUALLY TO PROVIDE ELECTRICITY TO OPERATE THESE APPLIANCES? (Draw a line from the appliance to the lump of coal with the number of pounds you guess to be correct! (Answers below)



Answers



AEROSOL SPRAYS

PURPOSE: To illustrate how a technological product can be modified to overcome its negative environmental effects, after they are identified.

LEVEL: Elementary School

SUBJECT: Science

CONCEPTS: Environmental management involves the application of knowledge from many different disciplines.

Conventional benefit-cost analyses do not always result in sound conservation decisions.

REFERENCE: New York State Education Department. Science, Technology and Society: Science Syllabus for Middle and Junior High Schools, Block J, 1985, p. 67.

BACKGROUND: The ozone of the Earth's upper atmosphere shields life on Earth from the intense radiation of the Sun. This protective layer may, in fact, be one reason for Earth's ability to support life.

In the 1970's, there was a growing suspicion that pollution from high-flying aircraft, above-ground nuclear explosions, and aerosol spray cans were depleting our protective blanket of ozone.

What caused aerosol cans to threaten our ozone layer? Fluorocarbons--the ingredient that makes those cans go "ffft."

ACTIVITY: Go to a local supermarket or drugstore and make a list of products sold in aerosol containers. Read several labels carefully and note the products that bear statements disclaiming fluorocarbons as propellents. What is the propellent in each product that disclaims fluorocarbons as the propellent?

Look at each different kind of aerosol product. Is there alternative packaging for each type, such as a pump spray or squeeze bottle?

Answer the following questions.

(a) What are the advantages of aerosol dispensers? Think of foaming shaving cream as an example.

(b) Fluorocarbons are still used in refrigeration units and heat pumps. Why is this use not a danger to the ozone layer?

(c) What other technological products can you think of that have been modified because of disadvantages in their use?

NOTE:

Use of fluorocarbons as propellents in aerosol cans has been discontinued. Other propellents, such as hydrogen, are now used.

FUTURES SCENARIOS

PURPOSE: To involve children in thinking about what may happen in the future, based on what is happening now.

LEVEL: Elementary School

SUBJECTS: Science
Social Studies

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

A cultural and time lag exists between the development of knowledge in science and technology and application of that knowledge to resource and environmental problems.

Options available to future generations must not be foreclosed.

REFERENCE: Ron W. Cleminson, et al. "Science Teaching and Environmental Concerns," 1982, pp. 153-157.

BACKGROUND: There are many bleak scenarios of the future, including these below. There are numerous other scenarios that are positive. They introduce a future where mankind prospers because our "world" concerns are seriously addressed. Obtained firewood, the effects of insect blight, and overpopulation are serious world problems today. We can let fate determine which scenario will occur. Or, we can act to choose the direction we want to move. Most individuals, given a choice, would hope to achieve positive scenarios for all citizens of "Island Earth," a "world perspective" which is essential today and will become critical in the future.

In an effort or attempt to achieve a "world perspective," we must introduce elementary school age children, as well as adolescents and adults, to science and environmental concerns. These world concerns and issues are immediately relevant to all of the earth's inhabitants. A concern- or issue-oriented curriculum, therefore, will make learning more meaningful because it demonstrates the need to understand basic environmental and science concepts.

ACTIVITY: <u>Scenario I: Energy</u>

One day we wake up to find that our environment has not become extinct. But we have!

What happened? "I was doing my math homework and everything seemed to be OK. The next moment I am talking with the angels.

Well, it seems that some small country I never heard of someplace on earth had a major fuel/energy problem. No, not nuclear or oil or coal or natural gas.

Firewood!

That's right. Firewood! The people needed fuel. No one really knew much about the problems of this small country and, could not have really cared less; no, we did care, I guess, but not enough to notice. So this small country with its military dictator decided to get the world's attention. He purchased the available "nuclear technology" to serve as a fuel source for his people from one of the major powers. However, when he obtained the knowledge necessary to serve as an energy source for his country, he also had the knowledge to develop nuclear weapons. He developed a nuclear bomb and fired it at a neighboring country to distract them while his armies looted firewood. The country being attacked then retaliated with their own nuclear warheads. The major powers jumped in to protect their "allies" and before long, the 50,000 nuclear bombs we have on earth were put to their intended use, destroying and killing. And, they did a fantastic job--not a thing was left. Nothing survived. After all, if my country does not survive, yours is not going to survive either. So there!

Scenario II: Food

Or, one day we wake up to find the environment has not become extinct. But we have!

What happened? I was watching television. The next moment, I was talking with the fallen angels!

Well, it seems that the rice crop failed on a world-wide basis and starvation was imminent for billions of people. Of course my refrigerator was only half full, so I could sympathize with their plight. If these countries only had better farm policies, this crop failure would not have happened. But the crop failure occurred in 65 countries. Could they all have had such bad farm policies? I am not a farmer and, besides, I have my "basics" or 3 Rs to teach my children. I asked one of the angels what happened? "Should we have sent some tractors to these countries? Or fertilizer?"

No. It seems that a blight attacked the rice crop and wiped it out.

Oh? So what? Plant a new crop and things will be OK.

Well, unfortunately, there is no more rice seed to plant.

You have to be kidding!

Nope! You see, several years ago, companies were allowed to patent seeds. No one really paid any attention to that. So these seeds got better and better and before long, all the farmers in the world were using these patented seeds. And, since they were so good, the other seed manufacturer's gradually were eliminated through good old competition. Finally, only one seed type for rice was left and 99 percent of the world used it. And, it was a great seed, producing abundant crops. That is, until the blight hit and killed the crop.

Gee, didn't something like that happen in Ireland in the 1800s?

Right on, good brother. Fortunately, the world population was not depending only upon those potatoes for sustenance.

Sure wish that were true now!

Scenario III: Population

Or, one day, we wake up to find that the environment has not become extinct. But we have!

What happened? I was preparing my report for social studies and everything seemed to be OK outside. The next moment I am reincarnated as a cricket on another planet. Chirp?

Well, it seems that the population of the earth grew and grew and grew. And finally, there was not enough food and space in some countries for all the people. But we, in our country, were not over-populated and business went on as usual. In these other countries, though, they forgot that there are only two solutions to over-population. One is to control the number of births, the other is to "encourage" death. Since we did not control births, then death must be the answer. And, some countries began using their nuclear warheads to give their people a chance to have space and food.

But those countries that had space and food did not really concern themselves with the problem. After all, they made their own bed so let them lie in it. But humans do not want to choose to die and will fight first. They did, others fought back, and the 50,000 nuclear warheads were put to their intended use.

Holy cow! If I had known that, I would have .....

DISCUSSION: These scenarios bear the elements of moral or ethical dilemmas; in each case, the student is asked to indicate how he or she thinks a given situation should be "handled." One point worth making is that there is no "right answer" for any of the scenarios, but a range of possibilities.

Discuss each of these scenarios with the class; encourage students to present their own ideas as to possible courses of action.

Encourage students to prepare their own scenarios--positive, negative, or "neutral." In each case, require that they document the information they use as background information, so that there is as much reality as possible in each.

Using student-generated scenarios, discuss as a class what possible options are option to deal with each.

MIDDLE/JUNIOR HIGH SCHOOL

SCIENCE/SOCIETY/TECHNOLOGY/ENVIRONMENT ACTIVITIES

ENERGY ALTERNATIVES

PURPOSE: To become acquainted with factors influencing energy policy.

LEVEL: Middle/Junior High School

SUBJECT: Social Studies

CONCEPTS: Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, ethical, and economic considerations.

A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

REFERENCE: Richard C. Clark, editor. A Portfolio of Energy Ideas. Social Studies, 1981, pp. AD2-3.

BACKGROUND: This is essentially a student research activity which may take from several days to two or three weeks. The activity contains a sample data recording sheet (p. 51). Most students will find that the space provided is much too small. Some students may want a full page per category. If you like it, ask your students to transfer the sheet to their notebooks.

There is so much published about energy that any bibliography is almost instantaneously dated. Magazines such as Audubon, Sierra, Time, Newsweek, Business Week, U.S. News and World Report, Science News, Saturday Review, The Atlantic and Harper's will probably be helpful. Most of these magazines have a position about various energy alternatives although it may not always be obvious. You and your students need to be aware of this.

ACTIVITY: Divide your class into groups of 3-5 and assign each group one of the following energy alternatives (change or substitute to fit your needs): nuclear, coal, petroleum, natural gas, energy conservation, and solar.

The class is going to act as a United States Energy Policy Commission. Each energy study group represents a sub-committee of the whole assigned to collect some information upon which to determine energy policy.

Students are to read books, newspaper articles, magazines (a wide variety), listen to the radio, watch television, and talk with local experts to gather information on the advantages and disadvantages of their energy alternative for six categories: environment, political, economic, attitudes, social, health, and safety.

The six categories are not exhaustive and you and the class may want to add, modify or delete categories. The categories are not necessarily mutually exclusive. Positive, or pro, and negative, or con, factors are to be considered for each of the six categories. Encourage examination of at least two pro and two con factors. The categories may be characterized as follows:

Environment: Impacts on the environment. How do nature and the alternative get along? What are the short- and long-term environmental effects? What is known? Of what are we less sure?

Political: What laws or policies exist which affect the alternative? What laws would need to be changed? What new laws are proposed? What are the effects of some of these laws?

Economics: How much does the alternative cost? Who pays? Is it "subsidized" (Government research money, tax benefits)? Will it create or cost jobs?

Attitudes: How do people feel about the alternative? What are the prevailing opinions? Who is for it? Against it? What are some of their reasons? How do opinions vary between interest groups, e.g., business and environmentalists?

Social: What are some possible effects on our social structure? Who stands to lose? Gain? What are the results?

Health and Safety: What are some health and safety considerations? Are there any hazardous by-products? What are they? What are the proposals to manage them?

SAMPLE DATA SHEET

Alternative

ENVIRONMENT

Advantages	Disadvantages
a _____	a _____
_____	_____
b _____	b _____
_____	_____
c _____	c _____
_____	_____

POLITICAL

Advantages	Disadvantages
a _____	a _____
_____	_____
b _____	b _____
_____	_____
c _____	c _____
_____	_____

ECONOMIC

Advantages	Disadvantages
a _____	a _____
_____	_____
b _____	b _____
_____	_____
c _____	c _____
_____	_____

ATTITUDES

Advantages	Disadvantages
a _____	a _____
_____	_____
b _____	b _____
_____	_____
c _____	c _____
_____	_____

SOCIAL

Advantages	Disadvantages
a _____	a _____
_____	_____
b _____	b _____
_____	_____
c _____	c _____
_____	_____

HEALTH AND SAFETY

Advantages	Disadvantages
a _____	a _____
_____	_____
b _____	b _____
_____	_____
c _____	c _____
_____	_____

ENERGY DEMAND FORECASTING

PURPOSE: To consider the effects of conservation of natural resources on forecasts of future demand.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Mathematics
Social Studies

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Options available to future generations must not be foreclosed.

A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

REFERENCE: American Petroleum Institute, Energy in America: Progress and Potential, 1981; Lester R. Brown and others, State of the World 1986, p. 87.

BACKGROUND: Those attempting to forecast future demand for natural resources must base their projections on historical patterns, current usage rates, and anticipated changes in need. Anticipated changes in need are difficult to forecast, because they include considerations for which actual data do not currently exist--for example, what numbers of people must be serviced by this resource in the future, what technological demands will there be in the future, etc.? As a rule, conservation of natural resources has not been considered as a modifying factor in projecting future demand because conservation efforts have not demonstrated appreciable influence on usage rates.

However, some recent data indicate that attempts at conservation, in this case through decelerated rates of increase in energy demand, can play a significant role in modifying projections of future needs. Since the mid-1970's, successive analyses have indicated decreased growth in demand in the area of energy use, as shown by the table below:

World Energy Use by Source, 1973, 1978, and 1984

Source	1973 Amount	1973 Share	1978 Amount	1978 Share	1984 Amount	1984 Share
	(mbd[1])	(percent)	(mbd[1])	(percent)	(mbd[1])	(percent)
Oil	56.0	41	61.6	41	57.1	35
Natural Gas	21.3	16	24.1	16	28.3	17
Coal	33.4	25	37.3	25	43.8	27
Renewables	23.5	17	25.8	17	28.7	18
Nuclear	1.0	1	3.0	2	5.7	3
Total[2]	135.2	100	151.8	100	163.6	100

[1]In terms of million barrels per day of oil equivalent. [2]Percentage totals do not add to 100 due to rounding.

Source: British Petroleum Company, BP Statistical Review of World Energy (London: 1985); Keith Openshaw, "Woodfuel--A Time for Reassessment," Natural Resources Forum, Vol. 3, 1978, pp. 35-51.

ACTIVITY: Questions for discussion and further research:

1. If one were to have based a projection for 1984 energy demand on the increase in energy use between 1973 and 1978, would he or she be likely to have projected the actual 1984 use? Why, or why not?

2. What happened to use of oil between 1978 and 1984? Might this have been projected in 1978 or before? Why, or why not? What was the actual cause for this change?

3. Because use of oil decreased between 1978 and 1984, what happened to demand for and use of other energy sources? Is this "good," or "bad?" Why?

4. Use the data provided in this table to make a projection for world energy use by source in 1990, both overall and by various sources. Write a scenario (explanation) which is both possible and probable to explain your projection.

DON'T WASTE TIME

PURPOSE: To predict what will happen in the event of a dangerous accident during the transfer of energy resources; to determine the cause/effect impacts of this situation on a nearby community.

LEVEL: Middle/Junior High School

SUBJECT: Social Studies

CONCEPTS: There are certain risks taken, and limitations experienced, when manipulating the natural environment.

Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Environmental management involves the application of knowledge from many different disciplines.

REFERENCE: Iowa Department of Education. Iowa Developed Energy Activity Sampler, 6-12, Revised, 1986, SS 3-4. Activity developed by S. E. Heiting.

ACTIVITY: The teacher sets the scene by telling students of a train derailment. The situation occurs near a town in south central Iowa. It involves a burning oil tanker and some rail flatcars holding containers of high level radioactive waste, which are being transported from Nebraska to the federal depository in Illinois. The students are given cards which separate them into groups with varying interests in the accident. Each group should view the situation from their respective roles and consider the weather, energy-economic factors, government responsibilities, and community response. The groups develop a news bulletin to inform the public about the incident. Each bulletin is displayed and the class reacts to the merits of each. The best parts are combined into a final news bulletin. Students develop a cause and effect chart to show the accident's impact on residents of a nearby community. An Iowa map is used to identify the probable locations of the accident and which town(s) would be involved. The cause/effect chart is developed with each student contributing an impact or opinion. Students research the probability of this situation or are given articles from the newspaper which demonstrate the reality of this event.

SOME SOCIAL OBSTACLES TO CONSERVATION

PURPOSE: To identify societal conditions which represent barriers to conservation.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Environmental management involves the application of knowledge from many different disciplines.

Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, ethical, and economic considerations.

A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

REFERENCE: Richard C. Clark, editor. A Portfolio of Energy Ideas. Social Studies, 1981, pp. SDE 2-6.

ACTIVITY:

1. Duplicate the opinionnaire (pp. 59-61).

2. Read the directions to your class. Emphasize and clarify all the directions.

3. Have the students mark the questionnaire. This may be done individually, or you may wish to experiment with responses elicited from small groups. Each group (4-6 students) would discuss the ideas and decide upon a group response (majority, consensus?) to each item.

4. Tally the responses on the chalkboard. "How many marked 'approve' for item #1?" etc. If the papers are anonymously exchanged, students may feel less sensitive about responses. You may want to calculate percentages. If you use this activity in more than one class, you can compare responses and also work out overall percentages.

5. Once tallied, the discussion can begin. These are some suggestions.

   - What are some of the reasons for particular opinions? How are they similar or different?

- Above all else, to really work, does energy conservation require a government policy that vigorously promotes conservation? Why or why not?

- When you hear about conservation of energy, which of the following most accurately reflects your thoughts and attitudes? Energy conservation is:

  a. Curtailment: energy savings are forced by interruption of supplies; results in unemployment, rationing, and severe cutbacks.

  b. Overhaul: dramatically changing the way we work, live, pursue leisure; outlawing suburbs and forcing people to live in certain places.

  c. Adjustment: learning how to use less energy than we have normally used to heat houses, manufacture items, travel.

- There are many alternative energy resources--wind, solar, coal, atomic, gasohol, geothermal, peat, etc. Have you ever thought about conservation as an alternative energy resource? What are some ways that it would help if we did? Would it help us to make better comparisons between the economics (payback period; savings in barrels of imported oil), safety and quality of conservation with those of another alternative?

- What is the difference in cost between an automobile that gets 13 miles to the gallon and one that gets 37 miles to the gallon in a year? What is the difference in energy savings between the two for the same time period?

- Each of us can contribute to energy savings. Together these individual acts can add up to a lot. Divide your class into small groups and present them with the following problem: You have just been assigned to the School Energy Conservation Committee. What recommendations would you make to help motivate everyone who is in school--students, teachers, administrators, employees--to participate in energy conservation efforts and to contribute to energy savings?

  Discuss the recommendations. Try to separate them into those that are coercive and those that reward energy savings. Are the two lists about the same length? Which do students think are more likely to work? Why?

  - If your school was told each month how it was doing on the energy savings task, do you think that would

be a useful recommendation? What do you think might happen as a result?

- When scientists try to solve some of this nation's energy problems, do you think they make matters better or worse? Give some examples. What about government? Business and industry?

- Who controls actions such as eliminating major energy waste in homes, industry, the area of transportation and business? Who should control them? If that didn't work, then what?

- Give an example of a common product no one really needs. How many agree with you? How would we get rid of it? Which of the following is the least popular area of conservation:

  a. the automobile,
  b. forsaking clothing fashions,
  c. lowering thermostat to 65°F,
  d. closing shopping centers on week-ends?

  What are some reasons for your choice?

- Is severe punishment (What kind would it be? Fines? Jail?) an effective way of controlling energy consumption? Who would decide? How would it be regulated? Can you suggest an alternative?

- List three energy conservation steps we can take as a society which are reasonably noncontroversial. List three energy conservation steps which are controversial. What would you suggest we do to promote just one of the controversial ones?

- Develop an advertisement which effectively advocates a particular conservation method. Get five opinions on it: from a teacher, a student, a relative, another adult and your closest friend. Is it effective?

- Which item in "Some Social Obstacles to Conservation" do you think is most ambiguous? Least ambiguous? How many agree with you?

- Rank order the top five on the list from most effective (1) to least effective (5). Rank order the bottom five on the list from least effective (0) to somewhat effective (4). Tally the class responses. How much variability is there in the outcomes? Use a histogram to show the results.

- Do you believe that energy use and economic growth are closely related, that is, that energy consumption encourages economic growth and that encouraging conservation would severely depress economic growth? Why or why not? What evidence do you have that your belief is correct or not?

OPINIONNAIRE

Directions: Each statement describes a possible societal condition which represents a barrier to conservation. For each statement, mark on the left-hand column with an X or a check whether you agree or disagree. In the right-hand column, note whether you think it will change or will not change even if it seems obvious what the response is.

Agree	Dis-agree		Will Change	Will Not Change
____	____	1. When you try to get a whole society to act, its members have to act in concert. Otherwise, if I save energy and you don't, the difference bothers me, I get angry and quit saving.	____	____
____	____	2. We know the skills needed for energy efficiency, but the whole force of our society has been in the other direction, the excessive use of energy.	____	____
____	____	3. It's clear that people from all over the country are not convinced they need to reduce their energy use. Everything in our culture has led them to act in a different way for the last fifty or sixty years.	____	____
____	____	4. The needs of families are too diverse for the idea of one-energy-policy-for-everyone. Whatever controls are adopted should be introduced at the level of institutions in the society--business, industry, transportation, and the like--and they must allow the autonomy of those responsible for the family's well-being.	____	____
____	____	5. If we ration energy, I worry about mobility, because for some people the car means a livelihood; others can do without it. The federal government may not have the capacity to make that distinction by law.	____	____
____	____	6. We should provide all kinds of incentives to reduce the number of cars used for getting to and from work. Fast lanes for buses. Subways, car pools. Those are the things that will make for a much saner society.	____	____
____	____	7. The less time we spend alone in cars and the more time we spend with each other, the healthier we'll be.	____	____
____	____	8. Policy makers, whether from government or the private sector, have to consider what the energy policy will do to families and to those who care for families. It must bring the family back as a responsible, coordinating unit that will conserve energy.	____	____

___	___	9.	We have to make sure that the people who don't get the heat and the light are not the poor. We have to make sure that public transportation, which the poor depend on, does not break down. The situation of the poor in the United States is the weak point, whatever the crisis.	___	___
___	___	10.	Although communes have problems, they are models of the future. They share. They conserve. People living communally are witnessing a way of life we all need to have. We need to share more, to give up some of our individuality and freedom for the greater good.	___	___
___	___	11.	We have to change our values, we have to shift from acquisition and hoarding to sharing, either by necessity--you share or you don't have--or by not rewarding people for accumulating.	___	___
___	___	12.	To many, the big car remains an object of envious adoration, and everywhere Americans still keep up with the Joneses. For their part, the Joneses seem to be going off on weekend trips in a gas-guzzling station wagon at 65 mph.	___	___
___	___	13.	While we lose sleep about keeping our thermostats at 65` during the savagery of Minnesota winters, absolutely unnecessary air-conditioners continue to churn in the beach hotels of Waikiki, and thousands of factories crank out products no one really needs.	___	___
___	___	14.	According to a recent Harris poll, more of us believe in "scientific research" to solve America's future energy problems than we do in "hard-working Americans."	___	___
___	___	15.	We reward people for accumulating. We strive to acquire things. Work and money are the most important factors in our lives.	___	___
___	___	16.	Young people may be able to project into the future and say they are going to organize their lives differently and not depend so much on energy.	___	___
___	___	17.	It's possible that young people who are crazy over cars will put some of their ingenuity into creating more efficient cars but it is doubtful that it will happen. They wouldn't get the kind of recognition for efficiency that they do for sleek, powerful cars.	___	___

____	____	18.	It is hard to adapt to labor-intensive, energy saving activities. Energy saving ways of acting are expensive in terms of time.	____	____
____	____	19.	I know all **I care** to know about energy conservation.	____	____
____	____	20.	America simply does not yet believe that the oil supply is finite and that other energy sources cannot take up the slack.	____	____

APPROPRIATE ENERGY TECHNOLOGIES

PURPOSE: To investigate the appropriateness of several energy technologies, in terms of energy efficiency.

LEVEL: Middle/Junior High School

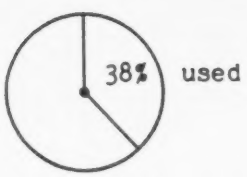
SUBJECT: Science

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

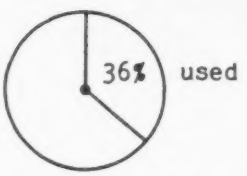
REFERENCE: Carol Wilson and Gary Krasnow. Science Study Skills Program: People, Energy, and Appropriate Technology, 1983, pp. 40-41.

ACTIVITY: Below are circle graphs which show how much energy is actually used and how much is lost in five different technologies.

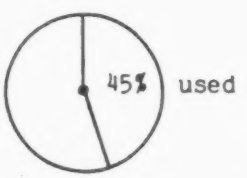
1) Shade the "energy loss" section of each graph.
2) Write in the percentage of energy loss on each graph.
3) Answer the questions below which ask you to compare the technologies shown in the graphs.



Average fossil fuel converted to electricity

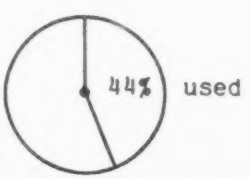


Oil (converted to heat) burned in a fairly efficient furnace



Steam engine (water power converted to mechanical energy)

Gasoline burned in an automobile (gas converted to mechanical energy)



Natural gas converted to heat in a fairly efficient furnace

1. How much energy is actually used when oil is converted to heat? _____

2. How much energy is lost when natural gas is converted to heat? _____

3. Which energy technology shown on page 62 is the most efficient (wastes the least energy)? _____

4. Which two technologies are the least efficient? _____

_____

5. Explain one way you could cut down on your use of one of the least efficient energy technologies shown on page 62. _____

_____

_____

ASSESSING THE EFFECTS OF TECHNOLOGIES

PURPOSE: To develop a strategy for assessing technological processes and devices.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

There are certain risks taken, and limitations experienced, when manipulating the natural environment.

REFERENCE: New York State Education Department. Science, Technology, and Society. Science Syllabus for Middle and Junior High Schools, Block J, pp. 64-65.

ACTIVITY: Using the chart provided (page 65), list the benefits and burdens placed upon people and the environment when each of the listed technological processes and devices are put into service in our society.

Place an asterisk in front of each technological process or device for which you feel the benefits outweigh the burdens. Be prepared to discuss your reasons.

How often did you and your classmates agree that a particular process or device should be (or should have been) adopted?

How can people assess whether or not to adopt a technological process or device?

Results are indicated in parentheses. Students should begin to realize that it is possible to assess technological processes and devices by the burdens and benefits they create. However, assessment depends on an ability to predict future consequences, which we may not always possess. When a decision is made to adopt or reject a particular process or device there may not be total agreement about that decision.

DATA TABLE

Technological Process or Device	Benefit	Burden
nuclear energy	(additional electricity)	(risk of war, radioactive wastes)
mass transportation	(less pollution, less energy used)	(personal inconvenience, large cost)
robotics	(modernized, efficient industry)	(loss of jobs)
drugs	(treat diseases)	(dependence through abuse)
pesticide/insecticide	(increased agricultural yields)	(extinction of helpful species)
product packaging with synthetic materials	(fresher food)	(nonbiodegradable waste in landfills)
computers	(increased ability to process data)	(loss of jobs, health problems from video-display terminals)
space travel	(increased knowledge)	(high financial cost)
life-sustaining devices	(keep people alive)	(how to decide when to use or remove them)
organ transplants	(increased life span)	(cost, decision as to who receives them)
radioactive isotopes	(medical treatment and diagnosis)	(increased risk of cancer)
automobile	(increased mobility)	(increased pollution, deaths)
chemical fertilizers	(increased agricultural yields)	(eutrophication of lakes)
artificial sweeteners	(convenience for diabetics and dieters)	(increased risk of cancer)
nitrites	(prevent botulism)	(increased risk of cancer)

ISSUES ASSOCIATED WITH NUCLEAR ENERGY

PURPOSE: To investigate some of the issues surrounding the use of nuclear energy.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Pollutants and contaminants are produced by natural and man-made processes.

There are certain risks taken, and limitations experienced, when manipulating the natural environment.

REFERENCE: New York State Education Department. Energy and Motion: Science Syllabus for Middle and Junior High Schools, Block G, 1985, p. 99.

ACTIVITY: As a class, make a list of nuclear energy issues. This might include the following:

- Do nuclear power plants threaten the safety of people living near them?
- How likely is a nuclear power plant accident?
- Can nuclear wastes be disposed of safely?
- What level of radioactivity is considered safe?
- Are safety procedures at nuclear power plants adequately monitored?
- Does the use of nuclear energy lead to proliferation of nuclear arms?
- Are nuclear power plants more or less cost effective than other power plants in producing electricity?
- Should nuclear energy technology be given to developing nations?
- Should the breeder reactor be developed?
- Does nuclear energy have fewer environmental and health effects than other energy sources?

Select the issue which interests you most. Do library research to find out as much as you can about the issue. Talk to

proponents and opponents of nuclear energy to find out their views on the issue.

Make a list of the arguments on each side of the issue.

Decide which side of the issue you stand on and explain why you chose this side.

MAKING WASTES USEFUL

PURPOSE: To investigate various methods of resource recovery.

LEVEL: Middle/Junior High School

SUBJECTS: Science

CONCEPTS: Environmental management involves the application of knowledge from many different disciplines.

Management is the result of technical and scientific knowledge being applied in a rational direction to achieve a particular objective.

REFERENCE: Edward E. Darrow, editor. The Science Workbook of Student Research Projects in Food-Agriculture-Natural Resources, 1985, pp. 81-83. (This activity was written by Sherman L. Frost, School of Natural Resources, The Ohio State University.)

BACKGROUND: We Americans produce an average of more than 6 pounds of wastes per person per day. That includes the waste from industry, from farm, from business, from homes. Some believe that the total may be nearer 20 pounds per capita in some places. We call garbage, ashes, abandoned cars, manure, refuse, cans, leaves, chemical and metal residues, for examples, wastes. It costs us great sums of money to dispose of wastes safely. Improper waste disposal can affect the quality of our environment, our air, our water, our land. We have many controversies where to put waste landfills. Finding land sites to dispose of waste is more and more difficult.

Resource recovery can lower the costs of waste disposal. It can lessen the need for landfills, lessen the problems of pollution and lessen the demand for new natural resources. Using wastes can create new jobs, new income, new businesses. And many wastes are made useful. Manure can be used for fertilizer. Aluminum cans can be recycled. Some wastes can produce energy. Waste heat can be captured and used. One of our challenges is the conversion of waste into new resources for mankind--called resource recovery.

ACTIVITY: Develop a use for waste product; contrast it with other ways of disposing of it; and, determine how it might be feasible. Do not feel restricted because there may already be a use for a waste. Maybe you can find a better one.

It is suggested that you select one waste product for your experiment. Examples include polluted water loaded with silt; a stream contaminated with mine acid; sludge from a sewage treatment plant or industry; litter; garbage; paper; cans;

sawdust; manure; etc. Do algae have a use? Or their components? What can you extract from leaves? We have a staggering "crop" of them each fall. Or you might want to select the waste from one industry in your area. We suggest caution on the waste you select because of possible hazards. Seek the cooperation from your industry or municipal water plant and to get waste samples. You can set up your experiment with that waste on a small scale.

You might want to consider making a model to show the waste "chain" of a product--like tomatoes from field to cannery to home to disposal to use then of the cans, sludge and other waste.

You might try using earthworms in a controlled bin, to decompose a mixture of municipally-digested waste, grass cuttings and newspaper cuttings to produce a compost product for gardening and more earthworms for fishermen. Keep some costs and see how you make out as a researcher and businessperson.

You could try to show the business-side of resource recovery. Collect the waste paper from an office or your school; see how much accumulates in a day, or a week, and add that for a year. Then get some prices from waste paper dealers to see the value of this paper. You could do the same on the newspapers collected and saved from your own home. How many dollars does it amount to?

You might want to make a map or exhibit of your state to show where recycling of waste is done, and what kinds of wastes are being used. You could use photographs, or drawings, or advertisements to illustrate.

THERE OUGHT TO BE AN ENERGY LAW

PURPOSE: To present views on energy use and to analyze their implications.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, ethical, and economic considerations.

A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

REFERENCE: Richard C. Clark, editor. A Portfolio of Energy Ideas. Social Studies, 1981, pp. TOL 2-3.

BACKGROUND: In this activity, students are given a list of energy uses (p. 72) that have been suggested for including in legislation which will mandate personal energy conservation. Some additional spaces have been provided on the data sheet so that you and your class can add other examples of proposed legislation. Students are in control of which uses will become illegal first and which last. They will rank the list as individuals first, but finally try to arrive at a group consensus. As students make decisions about limiting the personal freedom of themselves and their fellows, they will explore the value(s) at issue in each suggestion, and discuss what should be viewed as more important and necessary and for what reasons.

The data sheet lists a group of energy uses which will be included in energy conservation legislation. Tell your students to rank the list in such a way that the least valuable uses are legislated away first, and the most valuable last. In order to decide about first and last, students will need to understand what individual right or need is at stake in each energy use. Then they will need to make a judgment about which right/need is to be ranked as more important than which others.

ACTIVITY: **First.** Have the class read the list and add items to it or delete items from it. Everyone should write the suggested additions so that all are working with the same list.

Second. Have students quickly rank the list of energy uses by reading each item and making a quick decision about the value of each use. Column 1 is to be marked this way: Write in a 1 if

you feel the energy use could be quickly dispensed with; write a 2 if you feel the use would be important to allow as long as possible; write a 3 if you feel the use is necessary enough to make it among the last to go. These numbers are, of course, very arbitrary.

Third. Study each energy use and try to decide what human right/need/want is at stake in each item. Mark Column 2 according to your decision. Use these letters to identify what is at stake: L-making a living; H-health; S-safety; R-recreation; C-comfort and convenience; E-esthetics and natural beauty. There may be some overlap, e.g., between health and recreation. Decide which is primary, or use both letters.

Fourth. In small groups, compare your lists and try, through discussion, to come together on the choices wherever possible. Don't change your rank unless you've changed your mind!

Fifth. Now that you've discussed the value of the uses listed, you will probably make some changes in your ranking. To rank the choices in Column 3, use the same instructions that you did for Column 1. Disagree with the group if you do.

DATA SHEET

1. I Feel	2. At Stake	3. I Changed	Energy Uses Suggested for Conservation Bills
( )	( )	( )	Sunday and holiday driving limited to necessary trips only.
( )	( )	( )	Space air conditioners limited to hot climates only--none allowed in Minnesota.
( )	( )	( )	Auto air conditioners limited to hot climates only--none allowed in Minnesota.
( )	( )	( )	Self-cleaning ovens will be illegal.
( )	( )	( )	Self-defrosting refrigerators will be illegal.
( )	( )	( )	All indoor swimming pools will be closed unless solar heated.
( )	( )	( )	All indoor swimming pools will be closed except those designed for health and for educational uses.
( )	( )	( )	No automobiles getting less than ____ m.p.g. will be allowed.
( )	( )	( )	Higher rates for greater electrical energy consumption will be charged.
( )	( )	( )	Only one car per family will be allowed.
( )	( )	( )	It will be illegal to own/operate gasoline-powered lawnmowers on resident lawns.
( )	( )	( )	It will be illegal to own-operate snowblowers.
( )	( )	( )	No Instant-on TV will be allowed.
( )	( )	( )	No more small electrical gadgets will be allowed; canopeners, knives, toothbrushes, shaving cream warmers, individual hamburger fryers, waterbed heaters, etc.
( )	( )	( )	All non-emergency use of ORVs will be discontinued: motorcycles, snowmobiles, motorboats, etc.
( )	( )	( )	It will be illegal operate ski tows.
( )	( )	( )	
( )	( )	( )	
( )	( )	( )	

AFTER/WORDS

1. Which laws would curtail personal freedom the least? Which the most? What are some reasons for your decisions? How serious are these limitations on freedom of choice?

2. Which energy use ranked first? What are some reasons for these rankings?

3. How do we decide that it is better to manufacture necessities than luxuries or goods to help us have fun?

4. Are there any alternative ways of accomplishing some of these things that are reasonable for many/most people?

5. By limiting one person's recreation possibilities, it is likely that this will limit another's way of making a living. What are some things that can be done about that?

6. Which of these would force people to change the most? The least?

IMPACTS OF PAPERMAKING

PURPOSE: To consider the positive and negative social and environmental impacts of modern papermaking technologies.

LEVEL: Middle/Junior High School

SUBJECTS: Industrial Arts
Science
Social Studies

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: Donald Maley, editor. Math/Science/Technology Projects for the Technology Teacher, 1985, pp. 38-39. Activity developed by R. Scott Gray.

BACKGROUND: Paper was first made from bark, old rags, hemp waste, and fish nets more than 1800 years ago, but papermaking technologies entered the modern era only about 200 years ago with a process developed by Nicholas-Louis Robert. His process used an endless screen, onto which the fiber solution was poured. More recent developments involve the use of very large machines producing paper of endless length. These technologies have led to the development of a major industry which makes strong impacts, positive and negative, on both society and the environment.

ACTIVITY: As a research project, students should investigate both social and environmental impacts of modern papermaking technology. Among them are:

- the role that paper plays in an information-based society;
- the variety of uses of paper in modern society;
- the impacts of timber usage on the ecosystem;
- problems associated with paper litter;
- problems of disposal of waste paper;
- associated problems of air and waste production; and
- problems associated with paper recycling.

There are many others. The emphasis of the research project should be directed toward identification and analysis of both positive and negative impacts, both social and environmental.

NO-TILL PLANTING

PURPOSE: To show that acceptance of a technological process depends on the attitudes of individuals or societies to it, and involves consideration of related environmental factors.

LEVEL: Middle/Junior High School

SUBJECT: Science

CONCEPTS: A cultural and time lag exists between the development of knowledge in science and technology and application of that knowledge to resource and environmental problems.

Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, ethical, and economic considerations.

Natural resources are interdependent, and the use or misuse of one will affect others.

REFERENCE: New York State Education Department. Science, Technology, and Society, Science Syllabus for Middle and Junior High Schools, Block J, 1985, p. 54.

BACKGROUND: Conventional plowing methods have contributed to the loss of half of the nation's topsoil during this past century, and the loss is growing. Conventional plowing produces "clean" fields and good weed control.

Recently, no-till planting, or planting without turning over the soil, has challenged old methods. The advantages of no-till planting include:

- Wind and water erosion are reduced when the previous season's crops remain in place.
- Less fuel is used in growing crops because both planting and herbicide application are done in just one trip over the field.
- Decreased evaporation increases the amount of water in the soil that can be used by the crop.
- Winter ground cover provides protection to wildlife.

These are disadvantages to no-till planting, chief among which is the potential environmental impacts of extensive use of fertilizers.

ACTIVITY: 1. Interview farmers, conservationists, and environmentalists in your area and report your findings on no-till planting.

Some sample questions which you might ask include:

a. Is no-till planting better than conventional methods? Why?

b. What are the advantages, if any, of no-till planting?

c. Why do some farmers oppose no-till planting?

d. Should we influence farmers to start no-till planting?

e. How important is the conservation of topsoil?

f. Do the benefits from no-till planting outweigh the burden of herbicide dangers?

2. Discuss in class the views of farmers, conservationists, and environmentalists about no-till planting. What are your views? Why are these your views?

3. Conduct a survey among farmers to determine how widely accepted no-till planting has become.

MAKING JUDGMENTS: HOW DOES TECHNOLOGY AFFECT THE ENVIRONMENT?

PURPOSE: To differentiate between the fact and opinion, and exercise judgment based on facts.

LEVEL: Middle/Junior High School

SUBJECTS: Environmental Science
Language Arts

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Natural resources are interdependent, and the use or misuse of one will affect others.

REFERENCE: Carol Wilson and Gary Krasnow. Science Study Skills Program: People, Energy, and Appropriate Technology, Student Text, 1983, pp. 32-33.

BACKGROUND: The appropriateness of a technology depends, in part, on how it affects the environment in which it is used. The environment includes all of the land, water, and living things (plants, animals, people) in an area. In the desert, the environment includes sand, air, cacti, snakes, people, etc. On the coast of Iceland, the environment includes snow, ice, tundra, seals, fish, etc. A technology is most appropriate when it does not hurt or change the environment.

ACTIVITY 1: Directions:

Below are sketches of five houses. The houses are very much the same. Five people live in each, and each is designed and insulated in the same way. Each house is heated in a different way. The words under the drawings tell what form of energy technology is used to heat each house.

On the line provided below each house, rate each house as to how its energy use affects the environment. Use a scale of 1 to 10 to rate the houses. A rating of 1 means the house's heating system does little to hurt the environment. A rating of 10 means the system does great harm to the environment. Use the numbers 1 through 10 to show how much you think the energy use in each house affects the environment.

HOUSE A	HOUSE B	HOUSE C	HOUSE D	HOUSE E
Heated by electricity	Heated by burning coal	Heated by burning natural gas	Heated with oil	Passive solar heat and wood burning stove
RATING ON A SCALE OF 1 TO 10:				
_____	_____	_____	_____	_____

DISCUSSION: How did you decide on a rating for each house in Exercise I? Did you have the information you needed to make a good decision?

Making good choices or judgments often depends on having the facts. Without facts, you may end up basing your choice on opinion only.

A fact is something (events, pieces of information, data) which is accepted as true.

An opinion is a person's idea or belief. People may have different opinions or interpretations of the same event, data, or experience.

Example: Fact: John has brown hair.
Opinion: John's hair is beautiful.

Fact: The sun will set at 7:02 p.m.
Opinion: My view of the sunset is better than yours.

Activity 2: Directions:

Below are five sentences about strip mining for coal. Each sentence is either a fact or an opinion. In the space provided next to each sentence, write fact if you think it is a fact, or opinion if you think it is an opinion.

_____ 1. Strip mining is the least expensive way to remove coal from the earth.

_____ 2. The least expensive way is always the best for everyone.

_____ 3. In strip mining, soil and rock are stripped away so that the coal can be collected.

_____ 4. It often takes thousands of years before areas that have been strip mined return to their natural condition.

_____ 5. Coal is the most valuable resource in the U.S. today.

SUMMARY: Using Criteria

Once you have found the facts which will help you make a judgment, you need a way of comparing them. It is useful to develop CRITERIA or standards against which you can judge your information.

Example: Below are 4 criteria useful in judging how different kinds of energy technology affect the environment.

1. The technology should have little immediate or long term effect on living things.

2. The technology should not make the environment smell or look unpleasant.

3. The environment should be able to recover quickly from the technology.

4. The technology should not produce a lot of waste material.

THE PROBLEM OF WORLD HUNGER

PURPOSE: To illustrate that science and technology alone cannot solve society's problems.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Social Studies

CONCEPTS: The distribution and location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, moral, and economic considerations.

REFERENCE: New York State Education Department. Science, Technology, and Society, Science Syllabus for Middle and Junior High Schools, Block J, 1985, p. 51.

BACKGROUND: Most Americans get enough to eat, but more than one billion people who live in developing nations are classified by the United Nations as "seriously poor," and 500 million suffer from malnutrition. Many other newborn children die and those who survive show the characteristics of old age as early as age 50. Many of these people would starve without the food exported by the United States. Others survive by exploiting their natural environment through overfishing, overgrazing, and deforestation.

ACTIVITY:

1. Locate and read at least two current magazine articles about a recent or ongoing famine somewhere in the world.

2. In groups of three or four, discuss and answer the following questions.

   a. What is the problem to be solved?

   b. If you could get everybody to do what you wanted, what solution would you recommend?

   c. How successful do you feel your solution would be? Why?

   d. What problems do you foresee in feeding the world's population in the distant future?

3. Have one member from each group report what the group concluded.

DISCUSSION: The United States and other developed countries can teach underdeveloped countries farming techniques, resource management, and other techniques. However, in many places there is not enough rainfall for crops to grow, and overgrazing and overfarming are creating new deserts. To think that better crop management or better farming methods will solve the problem may be shortsighted. Other factors, some political, some social, also figure into the problem.

SHORT-TERM BENEFITS, LONG-TERM PROBLEMS

PURPOSE: To show that some long-term technological processes and devices have been used for their short-term benefits without attention to potential long-term negative effects.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Options available to future generations must not be foreclosed.

Conventional benefit-cost analyses do not always result in sound conservation decisions.

REFERENCE: New York State Education Department. Science, Technology, and Society: Science Syllabus for Middle and Junior High Schools, Block J, 1985, p. 54.

ACTIVITY: List the short-term benefits and potential long-term problems of each of the following technological processes or devices. (Possible responses are suggested, in parentheses).

DATA TABLE

Technological Process or Device	Short-term Benefit	Long-term Problems
nuclear energy	(electricity)	(radioactive waste)
chemical fertilizers	(higher agricultural yields)	(eutrophication of lakes)
insecticides	(higher agricultural yields)	(extinction of helpful species while target pests acquire immunity, contamination of water supplies)
artificial sweeteners	(convenience for diabetics and dieters)	(possible increased risk of cancer)
strip mining	(increased fuel supply)	(unusable land, water pollution)
nitrites	(prevent botulism)	(increased risk of cancer)
automobile	(increased mobility)	(increased air pollution)
modern-day packaging with synthetic materials	(fresher food)	(nonbiodegradable waste in landfills)
radioactive isotopes	(medical treatment and diagnosis)	(increased risk of cancer)
logging	(increased supply of wood products)	(deforestation of tropical jungles)

DISCUSSION: How are decisions made concerning the trade-offs between short-term benefits and long-term burdens? How much information is necessary, if these decisions are to be made intelligently? From where does this information come?

GLOBAL IMPACTS OF TECHNOLOGY

PURPOSE: To show that technologies may have widespread, even global, impacts and that beneficial technologies may have long-range negative impacts.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Management is the result of technical and scientific knowledge being applied in a rational direction to achieve a particular objective.

Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: New York State Education Department. Science, Technology, and Society: Science Syllabus for Middle and Junior High Schools, Block J, 1985, pp. 56-57.

ACTIVITY 1:

A. Define the terms vaccine and immunization.

B. Using a reference book, find out how the occurrence of disease is reduced and how diseases are eradicated.

C. Discuss with your classmates what you have learned.

D. How do vaccines affect world health?

ACTIVITY 2: Conduct a survey within your school building to find out how many people have and have not been vaccinated against smallpox. Ask their ages, and divide the people into the following age groups:

8-9 years old	14-15 years
10-11 "	16-17 "
12-13 "	18-19 "
	20 + "

Make sure you have the same number of people in each age group.

Graph your results on a bar graph.

What conclusions can you draw from your results? Are the numbers of smallpox vaccinations decreasing as the age groups become younger? If so, can you suggest a reason why?

RESULTS: In May, 1980, following a lengthy eradication campaign, the World Health Organization declared the world free of smallpox. Smallpox was able to be eradicated only because it was

transmitted by human-to-human contact. There were no intermediate hosts. Immediately following the WHO declaration, smallpox vaccination certificates as a condition for entry into another country were no longer required of international travelers. In May, 1983, distribution in the United States of smallpox vaccine for civilian use was discontinued. Student graphs should show a decrease in vaccinations at younger ages, with none occurring after 1983.

Further Discussion:

Because eradication of diseases such as smallpox decrease death rates, leading to longer life spans, the world's population is greater than it would otherwise be. Is this "good" or "bad," and why? How might this situation lead to a moral or ethical dilemma?

NUCLEAR MELTDOWN

PURPOSE: To investigate the causes and effects of a nuclear meltdown.

LEVEL: Middle/Junior High School

SUBJECTS: Language Arts
Science
Social Studies

CONCEPT: There are certain risks taken, and limitations experienced, when manipulating the natural environment.

REFERENCE: Iowa Department of Education. Iowa Developed Energy Activity Sampler, 6-12, Revised, 1985, SS 19-20. Activity developed by S. E. Heiting.

ACTIVITY: Students are provided with information, or library time, in order to gather data about the nuclear disaster at the Chernobyl reactor near Kiev, U.S.S.R., in Spring 1986. Students put key points of information on the blackboard and use them to determine a case study. Writing teams are assigned to develop the case study; one team writes about the background of the event, another team determines the impacts of the incident, and a third team makes pictures, charts, maps, or graphs to help illustrate the situation. The teams pool their resources and writing efforts to develop a finished product. The case study should be evaluated by the class and changes made as needed. Record a list of lessons to be learned from the event and make a statement which reflects student attitudes about the use and problems of nuclear energy.

NOTE: This format may be used as a model for any number of science/society/technology/environment case studies--Three Mile Island, the Bhopal Accident, and so on.

A SIMPLE TECHNOLOGY

PURPOSE: To devise a technological solution to an immediate problem, using simple materials.

LEVEL: Middle/Junior High School

SUBJECTS: Science
Physical Education

CONCEPTS: Natural resources are interdependent, and the use or misuse of one will affect others.

There are certain risks taken, and limitations experienced, when manipulating the natural environment.

REFERENCE: Pennsylvania State Department of Environmental Resources. Activities for Environmental Learning, 1984.

BACKGROUND: Situation--A group is hiking in the Alaskan wilderness when a pack of hungry wolves begins stalking them. To reach safety, the group must cross a deep ravine. Unfortunately, the rope suspension bridge across the ravine has broken and only one rope remains. The group members must take supplies with them.

ACTIVITY: Consider the remaining rope as a technology, and devise a method of crossing the ravine. Simulate your solution on the school grounds, using a tree and a rope. (Use 3/4 inch rope).

Possible Solution--The rope should be secured to a horizontal branch 35 to 40 feet off the ground. The end of the rope should be braided. The area beneath the tree should be free of obstacles for a distance of 30 feet on each side of the rope and for a width of 20 feet. Two to three inches of wood chips is preferable for a covering.

"Test" your solution by having class members (volunteers) attempt to cross the (simulated) "ravine." If a person or the supplies fall into the (simulated) ravine (i.e., don't make it across), the group must start over.

THERMAL POLLUTION: A MOCK TRIAL

PURPOSE: To understand that governmental agencies at state and national levels monitor the environment, make recommendations for laws, and monitor the implementation of the laws.

LEVEL: Middle/Junior High School

SUBJECT: Social Studies

CONCEPTS: A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

A variety of institutional structures is involved in planning and managing the environment.

REFERENCE: Carolie Sly. California Environmental Education Guide, 1981-84, Grades 7-9, 1981, pp. 84-86.

BACKGROUND: A summary of a case from The Environmental Law Reporter, March 1975, follows:

Jersey Central Power and Light operates a nuclear-powered electric plant located between the Forked River and Oyster Creek, a tidewater stream emptying into the Atlantic. A canal carries water from the Forked River to the plant. At that point, pumps force the cold river water beneath the plant, where it passes around condensers located underneath the nuclear reactors. This water, acting to cool and condense the steam created by the reactors, becomes heated some 25 degrees in the process. The heated water is then pumped into a canal that empties into Oyster Creek.

The artificially-warmed water of Oyster Creek attracts thousands of menhaden, a commercially important fish.

On January 28, 1972, the Jersey Central Power and Light plant shut down its nuclear reactors. But pumps continued to force the water from Forked River into Oyster Creek. The sudden infusion of cold water from the Forked River dropped the water temperature in Oyster Creek approximately 13 degrees in 24 hours. Shortly thereafter, more than half a million menhaden fish were found dead in Oyster Creek. Death was attributed to the thermal shock caused by the sudden drop in water temperature. The New Jersey Department of Environmental Protection brought suit against the Jersey Central Power and Light claiming violation of N.J.S.A. 23:5-28.

This statute, in part, states: "No person shall put or place into ... any of the fresh or tidal waters of this state any petroleum products, debris, hazardous, deleterious, destructive, or poisonous substances of any kind... In case of pollution of said waters by any substances injurious to fish, birds, or mammals, it shall not be necessary to show that the substances have actually caused the death of any of these organisms."

Prepare the class for a mock trial.

The teacher decides the total number of players who will be involved in the mock trial. A judge(s), plaintiff, defendant, plaintiff's attorney, and defendant's attorney will be needed. The teacher assigns roles. Additional witnesses may be called, some of whom can supply scientific testimony regarding tidewater ecosystems, the operation of nuclear reactors, and the laws of thermodynamics. Perhaps other roles, such as a bailiff, a clerk of the court, and a court reporter, might also be useful, and, of course, the jury.

Provide for the airing of opposing views, the introduction of supporting evidence, time for the jury to reach a decision, and time for the judge(s) to determine a sentence.

ACTIVITY:

1. Determine the cast and have the cast develop a position for each side.

2. Review trial procedures, making certain everyone understands his/her role and responsibilities.

3. The trial takes place.

4. Once the mock trial has run its course, the stage is set for the debriefing session. Debriefing permits participants to drop out of their roles and look objectively at the development of the two opposing positions. The teacher needs to guide the debriefing with key questions, such as:

   Q: What basic issue was in dispute?

   Q: What position was taken by the plaintiff?

   Q: What evidence supported the plaintiff's view?

   Q: What position was taken by the defendant?

   Q: What evidence supported the defendant's case?

   Q: What did the plaintiff's attorney do to present the plaintiff's evidence in the best light and to raise questions about the defendant's evidence?

Q: What did the defendant's attorney do to present the defendant's evidence in the best light and to raise questions about the plaintiff's evidence?

Q: (To the jury) Tell us the line of thinking you used in arriving at your decision. What would it have taken for you to change your mind?

Q: (To the judge) What line of reasoning did you use to arrive at your decision?

FOLLOW-UP: After the debriefing session, you can compare the outcome of the mock trial with the outcome of the real case upon which it was based. In the actual case, the New Jersey Court of Appeals:

- Found the company to be in violation of the statute. A $6,000 fine imposed by a lower court was upheld, as was an award to the state of $935 in compensatory damages (to pay for the fish that were killed).

- Rejected the company's contention that since the statute in question did not specifically mention thermal pollution, no violation occurred. Court interpreted legislative intent to include any substance that would be "hazardous, deleterious, or poisonous to life."

- Rejected the company's claim that "due process" was violated, since sometimes hot or cold water might not be a hazard and the company could not know in advance whether its actions would be construed as a violation. Court stated that the company knew that heated water had attracted the menhaden and that a drop in temperature might be harmful. It also admitted that they knew that continuing to run the pumps would result in a sharp drop in the temperature of Oyster Creek; and rejected the company's claim that action had resulted from an "unavoidable necessity." Court pointed out that the company's own representative had testified that cooling pumps could have been turned off when reactors were shut down. As a concluding activity, the teacher might wish to ask such questions as:

Q: What similarities are there between our decision and the court's?

Q: What differences are there between our decision and the court's?

Q: How might we account for those differences?

COMFORTS AND CONVENIENCES

PURPOSE: To consider the environmental impacts of the invention and development of modern technologies.

LEVEL: Middle/Junior High School

SUBJECT: Social Studies

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

Options available to future generations must not be foreclosed.

Natural resources are interdependent, and the use or misuse of one will affect others.

REFERENCE: New York State Education Department. Living within Our Means: Energy and Scarcity, 1974, pp. 70-71.

BACKGROUND: There is much discussion these days about the comforts and conveniences that Americans have come to enjoy and take for granted. Many hold that these comforts are the rightful benefits of an inventive, industrious people, while others suggest returning to a way of life in which self-sacrifice means self-renewal. These positions probably represent the two extremes, but an inescapable fact is that our American way of life requires that we use a disproportionate share of the world's resources.

ACTIVITY: Have the class consider the origins or the seeds of the lifestyle we enjoy. A small group of students might undertake a research project: tabulate 10 to 20 major inventions or developments which spurred progress, made life easier and more interesting, or "improved the human condition," for each of the three periods: 1825-1875; 1875-1925; and 1925-present. The group should then present its research to the class for discussion, along with illustrations and pictures to dramatize the reporting. (The scope of this activity is such that it might be considered for use as a recurring theme in the year-long course of study.)

- Did there seem to be a noticeable increase in the numbers of significant inventions (available to choose from for your lists of 10 to 20) at any time, or throughout the three time periods? If so, can you offer any explanation?

- At any time, did you notice that research led you to lists of inventions which seemed to include many frivolous or unnecessary gadgets and inventions? If so, give examples and specify the time period(s).

- Would the removal of any of these major inventions from the list have altered the course of human events? Explain.

- For the third era (1925-present), did you find any items which the world could have as easily done without? If so, what are they and why would we be as well or better off without them?

- Can you establish specific relationships between any of these inventions and such things as energy shortages, resource depletion, and environmental degradation? Elaborate.

- Many parts of the world have obviously not benefited from the inventiveness and creativity you have recorded. Can you explain this? Can you justify this?

- If the world were to derive these benefits to the extent that Americans have, can you speculate on the environmental effects of such universal progress?

- Make two tables for the period present-2050. On one, list the descriptions of five to 10 inventions or developments you feel are <u>likely</u> to emerge. On the other, list those which you think are necessary or urgent and <u>ought</u> to appear.

SENIOR HIGH SCHOOL

SCIENCE/SOCIETY/TECHNOLOGY/ENVIRONMENT ACTIVITIES

USING SOIL TO TREAT WASTES

PURPOSE: To investigate methods by which soil is used to treat waste materials, and problems associated with these methods.

LEVEL: Senior High School

SUBJECT: Chemistry

CONCEPTS: Pollutants and contaminants are produced by natural and man-made processes.

There are certain risks taken, and limitations experienced, when manipulating the natural environment.

REFERENCE: Edward E. Darrow, editor. The Science Workbook of Student Research Projects in Food-Agriculture-Natural Resources, 1985, pp. 90-91. (This activity was written by Dr. Terry Logan, Department of Agronomy, The Ohio State University.)

BACKGROUND: Soil has always been used for disposal and treatment of wastes including garbage (as in garbage dumps and landfills), manures and sewage sludges and remains of deceased animals and humans (burial). Today, more complex, and potentially more hazardous, organic chemicals are placed in soil where soil microorganisms are utilized to break them down to harmless products.

Decomposition of organic compounds in soil is primarily performed by heterotrophic bacteria and fungi. These are microorganisms which derive energy and carbon for biomass growth through the process of respiration. In respiration, the organic compound (represented by the empirical chemical formula CHO) is converted by the organism in the presence of oxygen to carbon dioxide and water, biomass and energy:

$$CHO + O_2 \longrightarrow CO_2 + H_2O + \text{biomass} + \text{energy}$$

The rate at which respiration occurs is proportional to the amount of CO_2 produced, and CO_2 concentration can be monitored to measure the progress of the reaction.

ACTIVITY: Measure the effects of environmental (e.g., soil moisture content, temperature, nutrient supply, chemical environment) and substrate (type of waste material, e.g., a pesticide, sewage sludge, shredded newspaper) characteristics on the efficiency of organic waste degradation in soil as measured by CO_2 evolution.

The soil/waste mixture is contained in a vessel such that the CO_2 produced can be collected and measured. A simple system utilizes a small (0.5-1 liter) jar with a tight screw-cap lid. The soil/waste mixture is placed in the jar to allow 50-75% head

space and a small vial of 2M NaOH is placed on the soil surface to trap the CO_2. The jar is periodically opened and the excess NaOH is titrated against standard acid in the presence of 1M $BaCl_2$ to precipitate $BaSO_4$ which would otherwise interfere with the titration. A jar containing no waste is used to determine CO_2 produced from background decomposition of soil organic matter. The jars should be incubated for at least four weeks and CO_2 evolved should be measured each week. The cumulative CO_2 evolved is plotted against time and the rate of CO_2 produced is calculated.

Variables which could be investigated with this system include: type and concentration of the waste; soil temperature and moisture content; soil type; soil pH; level of added nutrients, particularly nitrogen; effects of inhibitory substances such as pesticides, toxic metals, etc.

THE GREEN REVOLUTION

PURPOSE: To recognize the impacts of agricultural practices on the total environment.

LEVEL: Senior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

A cultural and time lag exists between the development of knowledge in science and technology and application of that knowledge to resource and environmental problems.

The distribution and location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

REFERENCE: Michael J. Caduto, A Guide for Environmental Values Education, 1985, pp. 54-55.

BACKGROUND: In the 1950s, agricultural experts from around the world began the Green Revolution. By sending technical help to the farmers of the developing, overpopulated countries, the experts hoped to assist the farmers in growing more and better food crops. Geneticists developed climate-adjusted strains of wheat, corn, and rice that would yield large amounts of nutritious grain. Engineers built tractors and harvesting machines that could cut labor and save grain. Chemists made fertilizers that turned poor farmland into good cropland. Irrigation systems were installed to expand growing space in desert countries.

Between 1950 and 1970, wheat production rose from 270,000 metric tons per year to 2.35 million. Corn production increased 250 percent. India alone increased grain production 2.8 percent a year.

But all is not rosy in the Green Revolution. In another country of the Asian region, food-producing acreage jumped from 50,000 to 32 million acres in less than ten years. To work that much land requires a huge investment in machinery. The machines are made abroad and the country practicing the Green Revolution has become totally dependent on foreign countries for tractors as well as for harvesting and milling equipment. Machines take the place of people. The farm-labor force in certain agricultural regions has dropped 50 percent in the 1970s, and in Latin America 2.5 million farm workers lost their jobs in just one year.

The seeds, machines, and fertilizers are not given to the developing countries free of charge. The Green Revolution puts a great strain on the economies of these countries.

In many countries, much of the land used for increased production was not well-suited for agriculture. In many cases, application of Green Revolution technologies has created environmental problems--erosion, siltation, deforestation, and desertification, and so on.

ACTIVITY: Discussion questions:

1. Are these countries spending their resources in the best way?

2. What trade-offs are being made, between present and future?

3. The Green Revolution is machine-intensive, not labor intensive. Most developing countries have an abundance of workers, but little capital to spend on machines. Because of the high cost of energy, nearly every country "revolutionized" by the Green Revolution is today importing food. Propose a solution to this situation.

4. Of the world's 4.5 billion people, at least 1 billion are inadequately nourished. About one-third of the deaths that occur throughout the world are due to the effects of malnutrition. Propose a solution to this situation.

EDUCATED GUESSES

PURPOSE: To make an hypothesis statement and locate quotations which will support or reject the statement, determining if the evidence justifies accepting or rejecting the statement and/or modifying the hypothesis.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPTS: Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, ethical, and economic considerations.

Environmental management involves the application of knowledge from many different disciplines.

REFERENCE: Iowa Department of Education. Iowa Developed Energy Activity Sampler, 6-12, Revised, 1986, SS 103-108. Activity developed by S. E. Heiting.

ACTIVITY: After a discussion or unit on energy technologies, students are asked to write a hypothesis which states something they think may be true about the U.S. energy situation today. Students then read a number of quotations such as those provided (pages 100-103). The students select 3-5 quotes which support and do not support their hypothesis. The library or classroom resources are used to help students determine if the hypothesis statement is accurate.
Students state why they are accepting or rejecting the hypothesis. Modifications of the hypothesis should be made if needed. Students share the conclusions of their work and discuss what the implications of their findings mean in terms of current U.S. energy use. Each student is directed to originate their own energy quotation to be posted or displayed on a board labeled "Notable Energy Quotes."

THE ENERGY DEBATE

Everything is connected in ways we cannot begin to imagine. The hunger problem is not the hunger problem. It is the poverty problem. It is the pollution problem. It is the energy problem. It is the war problem, the arms problem. All those problems are inextricably connected, and you don't solve one without solving them all. Things that will work for one will work for all.

Dana Meadows--systems analyst
speaking at the 1978 World
Hunger Symposium

The sun radiates energy at a rate of 400,000,000,000,000,000,000,000,000 watts. Half a billionth of that goes to the earth. Of that fraction, about a third bounces off immediately and almost another third remains at the surface to drive the climate. Living things, intertwined by their individually tiny but collectively vast flows of energy, have been evolving for several billion years within the constraints of energy income available to them. They work very well and know exactly what to do, even though they have never been to engineering school.

Jim Harding, 1975

The United States puts 45% of its total energy into vehicles: to make them, run them, and clear a right of way for them when they roll, when they fly, and when they park. Most of this energy is to move people who have been strapped into place.

For the sole purpose of transporting people, 215 million Americans allocate more fuel than is used by 1,300 million Chinese and Indians for all purposes. Almost all of this fuel is burnt in a rain dance of time-consuming acceleration.

Ivan Illich, Energy and Equity, 1974

I blame squarely the West for certain models that they have introduced to us; one is the consumer society, the other is gigantism. We are still stuck with them. The gigantism: big dams, big projects, roads, cars for everybody. We cannot afford cars for everybody; not even one person in one hundred has a car. We must have mass transportation. We took the wrong road for a number of years. We are now realizing we're on the wrong road but it takes a long time to make a turn.

Ajit Bhattacharjea--Editor, Indian Express newspaper, New Delhi, India

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The diversity of soft technology makes it particularly easy to recycle existing industry, especially the car industry which doesn't have a good long term future. General Motors, I understand, has recently converted a car radiator factory to make solar collectors which are, more or less, car radiators inside out.

Amory Lovins, 1978

The whole universe, including that which we call physical, can be treated in terms of information, and it is clear that information is constantly increasing. The supply is essentially unlimited, for we can always generate new information in the universe of the self--make new discoveries, new choices, put old things together in new ways--and this is bound to influence the future. To influence the future consciously, then, taking responsibility for the outcome of this influence, is to participate fully in the ultimate adventure.

George Leonard, The Silent Pulse, 1978

A General Public Utilities survey shows that 58% of its customers have altered household routines to help cut down the use of electricity in the day time. This means more nighttime laundering, baking, and dishwashing.

Wall Street Journal, August 24, 1978

Material thrift has become almost impossible; the system conspires against it. As a society, we assign the highest value to our leisure and therefore a lower value to all things that might demand our time and attention. Disposable, self-cleaning, self-defrosting, easy-to-use, ready-to-wear, ready-to-eat, three-in-one, all-purpose--these are the adjectives that get our consumerist juices churning. No matter that the time most of us save we then fritter away in front of the garrulous TV.

Carll Tucker in Saturday Review, August, 1979

Warning: This air conditioner is hazardous to your health and to the environment. This model, used in normal operation in your locale (1,000 hours in the summer months) will require the consumption of a pound of coal (or equivalent fuel) per hour of operation. This air conditioner will consume a half ton of coal during the summer, most of which comes from strip mining. In addition, the generation of pollutants from the electric power plant where the coal is burned may cause disease and property damage. The Surgeon General . . . advises use of trees for cooling and shading, natural ventilation when possible, and alternatively, when necessary for mechanical ventilation, the

use of electric/ fans which consume one tenth the energy required for this machine.

Air conditioner label suggested by Wilson Clark in Energy for Survival, 1975

Any dramatic rise in water usage will force . . . hard choices . . . It takes only seven gallons of water to refine the equivalent of a billion BTUs from Standard Oil of California's Richmond oil refinery. But it takes twice that much water to get the same energy from nuclear reactors and three to four times as much that amount to get it from oil shale. In addition, many of the "new generation" fuels, like geothermal, also consume much more water when they are used to generate power.

Kathleen Wiegner in Forbes, August 20, 1979

The Second Law equation says that energy cannot be recycled, and that matter can only be recycled by expenditures of energy--always at less than 100% efficiency. When we ignore the Second Law of Thermodynamics, we do so to the dismay of our land and air and water. These are the components of the biosphere that must act as a blotter for the Second Law wastes we generate as we use energy.

Jean Matthews in Trends, May 1979

One of the peculiarities of the human animal is his lack of group providence . . . as a social creature, he will not accept any warnings that interfere with daily business.

Donald E. Carr

We should build the south side (of the house) loftier, to get the winter sun, and the north side lower to keep out the cold winds.

Xenophon, Greek historian, 400 B.C.

Few will have the greatness to bend history itself, but each of us can work to change a small portion of events, and in the total of all these acts will be written the history of this generation.

Robert F. Kennedy

Man on a bicycle can go three or four times faster than the pedestrian but uses five times less energy in the process. He carries one gram of his weight over a kilometer of flat road at the expense of only 0.15 calories. The bicycle is the perfect transducer to match man's metabolic energy to the impedance of locomotion. Equipped with this tool, man outstrips the efficiency of not only all machines, but all animals as well.

Ivan Illich

Our most optimistic estimates indicate that solar electric generating capacity might represent about one percent of the total installed capacity by the year 2000. Despite accelerated research and development efforts in alternative energy forms, sources other than fossil and nuclear fuels will be supplying only about ten percent of electric generation by the year 2000--and more than half of that will be hydroelectric.

H. V. Young
Edison Electric Institute

ENERGY RESOURCE MANAGEMENT

PURPOSE: To construct and defend a presentation advocating one particular source of energy which merits additional governmental encouragement.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPTS: Options available to future generations must not be foreclosed.

Environmental management involves the application of knowledge from many different disciplines.

Conservation policy is determined by the interaction of science and technology; social and political factors; and estheric, ethical, and economic considerations.

A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

REFERENCE: Floretta McKenzie, Competency Based Curriculum Guide: Science and Social Issues, 1983, pp. 275-278.

BACKGROUND: This lesson is designed as a review of issues on nuclear energy, value judgment, and resource management. It is hoped that students will acquire a heightened social awareness of the importance of energy decision-making, and that they will develop the talents and self-confidence needed to involve themselves in this process as future participants in the democratic system.

ACTIVITY 1: Help students develop a master list of sources of energy. A class discussion of the relative benefits of each source will be held to identify individuals likely to be effective advocates of particular energy sources as being worthy of increased federal encouragement. From this nucleus, the class will be divided into lobbyist groups.

Insure that each source of energy studied has a group, and that to the extent possible each student is placed in a group whose position he favors. One group will be reserved to serve as the Senate Energy Committee, and another as concerned environmentalists.

Once this organization is established, the teacher will assign each lobbyist group the task of researching and organizing data supportive of the concept that the chosen source of energy is the

one most deserving of governmental assistance. The Senate Energy Committee group will be charged with developing criteria to be used in evaluating the lobbyist groups' presentations and the environmentalists will develop data on which energy sources have the least environmental impact.

ACTIVITY 2: After sufficient supervised research and discussion, divide the class and arrange the classroom as a Senate Committee hearing room. Have students role play the positions described above. Expect all participants to maintain a chart of energy sources, listing benefits and costs, as they are brought out in debate and testimony.

ACTIVITY 3: Following the preceding instructional activity which used a Senate Committee debate, each student will be elevated to the rank of senator and develop his personal position on a national energy policy. A floor debate will then be held, allowing each student to give input into which energy resources should be given governmental impetus.

COST VS BENEFITS CHART FOR SOURCES OF ENERGY

SOURCE	AVAILABILITY TODAY	AVAILABILITY IN 50 YEARS	TODAY'S NEED FOR IMPORTS	DO WE HAVE TECHNOLOGY?	ADDITIONAL TECHNOLOGY NEEDED	ENVIRONMENTAL IMPACT	CURES FOR ENVIRONMENTAL IMPACT	COST	REMARKS

ARTIFICIAL REEFS IN LAKE ERIE

PURPOSE: To investigate the consequences of the construction of artificial reefs in marine environments.

LEVEL: Senior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Management is the result of technical and scientific knowledge being applied in a rational direction to achieve a particular objective.

Natural resources are interdependent, and the use or misuse of one will affect others.

REFERENCE: Edward E. Darrow, editor. The Science Workbook of Student Research Projects in Food-Agriculture-Natural Resources, 1985, pp. 27-28. (These activities were prepared by Dr. Rosanne Fortner, School of Natural Resources, The Ohio State University.)

BACKGROUND: The Ohio Sea Grant program has been working with the communities along the shore of Lake Erie to develop and implement plans for the construction of artificial reefs in the Central Basin. Their purpose was to provide spawning and feeding sites for lake fish, attracting more sport species like walleye and white bass to the area and thus build the tourist economy. The Western Basin has long had the greatest abundance of sport fish because of the presence of numerous rock structures on the shallow basin floor.

Freshwater artificial reefs have been constructed throughout the United States in such areas as Muskegon, Michigan. The Hamilton Reef there has about 4,000 tons of rock piled 3-6 feet high in water 26-42 feet deep. Early studies show that the reef attracts sport and bait fish species, especially yellow perch. The perch also spawn there.

The reefs in Lake Erie are a project of the Sea Grant Extension Program of The Ohio State University. Construction permits are held by the Ohio Department of Natural Resources Division of Wildlife. The first sections of a reef were put in place in August, 1984, and studies of their colonization by lake plants and animals could serve as a model for what can be expected in other freshwater artificial reefs.

NOTE: These activities are designed for projects for individual students, or small groups of students. Though they are written for Lake Erie, they are adaptable to other locations.

ACTIVITY 1: Document the research on the Western Basin reefs that encourages the notion that they attract desirable fish species: what types of fish, numbers, seasons, and reef depths are most attractive?

ACTIVITY 2: Document the research that has been done on construction of artificial reefs at sea and in other lakes to attract fish. What success stories are there, and what disasters would this new effort need to avoid?

ACTIVITY 3: Using bathymetric charts, diagram the bottom topography of Lake Erie and indicate what factors went into the choice of sites for new reefs. What is the bedrock like? Where are there concentrations of sediments? What pollution sources must be avoided, etc.?

ACTIVITY 4: Document the history of development of community support for the reef project. What steps were taken, who was responsible, what happens next?

ACTIVITY 5: Simulate a reef environment with a computer program. Estimate the effects of various factors on reef success using existing data on water quality, fish movement patterns, seasonal changes in lake stratification, etc. Introduce algae blooms, early ice development, new predator fish, new fishing regulations, and determine the effects on the reef ecosystem.

ACTIVITY 6: Study actual Lake Erie reefs using SCUBA. Measure water characteristics at various distances from the reef, catalog the species observed, and monitor changes monthly as weather permits. Compare new reef conditions with those of the ancient reefs in the Western Basin.

ACTIVITY 7: Obtain permission to screen off a section of the new reef for controlled monitoring of some fish that you bring into the area. Make sure your fish are acceptable in the ecosystem first by discussing with experts. Design some measurements that you will take weekly to see if your fish are thriving or in need of something that the reef or the incoming water does not provide. Before working with a live population, be sure you know about the needs of the species. You are not trying to change its life-style, only see what the reef has to do with its survival and growth.

ACTIVITY 8: Based on #5, 6, or 7, develop hypotheses about the sequences of changes that the reef will experience as it develops into a habitat. Include both living and nonliving environmental changes. Predict what would have to happen with reefs or other environmental management in the Central Basin for it to become as important a sport fishing area as the Western Basin.

CONTROLLING ENVIRONMENTAL POLLUTION

PURPOSE: To describe environmental pollution control in terms of the laws or regulations used, the agencies responsible, and the effectiveness of the process.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPTS: A variety of institutional structures is involved in planning and managing the environment.

Pollutants and contaminants are produced by natural and man-made processes.

A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

REFERENCES: Floretta McKenzie. Competency Based Curriculum Guide: Science and Social Issues, 1983, pp. 196-202; Sherman L. Frost, 203 Significant Federal Laws Concerning Natural Resources and the Environment and the Creation of Related Agencies, 1986, pp. 23-29.

BACKGROUND: Many students will mistakenly assume that we can control pollution by setting up various agencies and by passing laws. This simply isn't true. However, students should have first-hand knowledge of how environmental control agencies work and how laws are developed, their effectiveness, and whether or not they are being enforced. The primary purpose of these activities is to help students become more aware of the functions of these agencies and laws.

ACTIVITY 1: Have students research the legislative acts that regulate environmental pollution control and discuss thoroughly their content. (A listing is provided after Activity 3.)

ACTIVITY 2: Explain to the students that there are many agencies that are responsible for the control of pollution. This activity is designed to develop awareness of and knowledge about the functions of these agencies.

Several agencies that share the responsibility of control are listed below, as examples. In different places, they will have different names and perhaps somewhat unique missions, so a localized list must be prepared. Divide the class into small groups and assign an agency to each. Have the students research and report on the agencies and their functions.

-Environmental Protection Agency
-Department of Human Resources
-Department of Environmental Services
-Council of Governments
-Solid Waste Reduction Center
-Federal Energy Regulatory Commission
-Environmental Quality Council
-Citizens Environmental Council

If possible, have the students visit the agencies or organizations after making contact and determining who to see and where to go, to obtain first-hand information. Have them report orally to the class, and also submit a written report.

ACTIVITY 3: Using the provisions of the Acts as guidelines, develop a number of problem situations that involve the violation of the acts. Present these to the students and have them determine which act is being violated.

Ex. A barge carrying oil overturns in the Chesapeake Bay, creating an oil spill that moves inward toward the beach area. (Water Quality Act is violated.)

FEDERAL LAWS RELATING TO POLLUTION

Title or subject area:	Provisions
Rivers and Harbors Act (1899)	The act makes it a criminal offense to dump any sort of material that interferes with navigation into a river or harbor. Provides for a fine (not to exceed $2500) and/or imprisonment of up to one year for each violation.
Water Quality Acts	The Water Quality Act of 1965 required all of the states to set water quality standards and have them approved by the federal government. It required that all water discharged by industries should, by 1973, undergo at least "secondary treatment." The Federal Water Pollution Control Act of 1972 amended the first act and established a national policy for the prevention, control, and abatement of water pollution. This act provides funds for: (1) water

	pollution control programs, (2) grants for research, (3) development and construction of treatment plants, (4) enforcement measures, and (5) control of oil spills and sewage discharges from vessels. The Federal Water Pollution Control Amendments of 1972 called for the use of the best practical control technology by 1977 and the best available control technology by 1983. Also check for more recent modifications including the Clean Water Act of 1987.
Acid Precipitation Act (1980)	Established an Interagency Task Force to plan and implement research programs to clarify the causes and effects of acid precipitation.
Clean Air Acts	The Clean Air Act of 1977 amended the 1967 Air Quality Act and empowers the federal government to protect and improve the nation's air resources and the public health and welfare. Some actions taken under the act are the controlling of emissions from new automobiles, setting air quality standards, and encouraging and developing emission standards for new industries built anywhere in the United States.
Acid Precipitation Act (1980)	Established an Interagency Task Force to plan and implement research programs to clarify the causes and effects of acid precipitation.

Noise Pollution and Abatement Act (1970); Quiet Communities Act (1978)	Provided for a study to identify and classify causes and sources of noise problems and to determine their effects on human health and welfare.
Waste Disposal Acts	The Solid Waste Disposal Act of 1965, the Resource Recovery Act of 1970, and the Resource Conservation and Recovery Act (1976) provide funds for demonstration projects, resource recovery systems, the training of personnel and planning including a comprehensive plan for the storage and disposal of radioactive materials, toxic chemicals, and dangerous biological materials.
Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) (1980)	Authorized a $1.6 billion fund to clean up old hazardous waste sites and spills of hazardous materials. It is considered a landmark law because of its magnitude, intent, and proposed action on sites and the ability of the government to sue to cover its expenses.
National Environmental Policy Act (1969)	Requires all proposed federal projects to be evaluated for their impact upon the environment before being carried out. These evaluations are put into a report circulated to all United States government agencies for review and comment. Each agency must publicly file its position on the proposed project. The conditions of this act have influenced many projects and caused the redesign of others in order to reduce their impact on the environment.

Occupational Safety and Health Act (1970)	Provides for protection of the person in the working environment. It sets standards and criteria for various industrial activities and also sets penalties for violators. The Act covers, among other things, standards for human exposure to gases, vapors, aerosols, and noise, and standards for the installation and use of safety guards, ladders, and other safety equipment.

ACTIVITY 4: Have the students discuss the problems that relate to conflicts such as the following:

- How can a water treatment plant under the direction of a Department of Environmental Services, cause air or solid waste pollution, while trying to control water pollution?

Identify other such conflicts from the reading and present these for discussion.

ACTIVITY 5: As the students visit agencies that are responsible for pollution control, have them explore the effectiveness of the control process. Have them discuss with their contacts, at these agencies, cases of violations and what was done about them.

Have them locate instances where litigation is still in process and research the history of the cases as they move through the litigation process.

Have them investigate the effectiveness of control measures such as the catalytic converter on vehicles to reduce the emission of exhaust fumes; are these still being placed on new cars? Are checks made by the Department of Motor Vehicles to determine if motorists keep them on their cars? What happens to a motorist who decides to remove the converter and is discovered by the law?

Identify other such situations as they arise in the reading and discussion and use them as points for discussing the effectiveness of control measures.

ASSESSMENT TASKS:

1. Describe the pollution control measures used by two of the following agencies:

   -EPA
   -Department of Environmental Services
   -Federal Energy Regulatory Commission
   -Environmental Quality Council

2. Match the incidences of pollution in column I with the laws that they violate in column II. Place the alphabet representing the law or act in the blank opposite the incident.

I	II
_____ release of radioactive materials from a power plant into the atmosphere	A. River and Harbor Act of 1899
_____ release of heavy smoke and particles from a factory into the air on the outskirts of a major city	B. Water Quality Acts
_____ dumping junk cars into a river	C. Occupational Safety and Health Act
_____ release of liquid chemical waste by a factory into a river	D. Noise Pollution and Abatement Act
_____ an airport using a flight pattern, for landing jet airplanes, that goes over a residential area	E. Solid Waste Disposal Act of 1965
_____ a company refuses to make provisions for the welfare of its employees in terms of safety measures to protect them from excessive noise pollution	F. Clean Air Acts

3. Choose an incidence of pollution violation that you have discussed in class and describe the effectiveness of the control process in dealing with it.

FOOD QUALITY

PURPOSE: To describe the role of the food industry in controlling the quality of food and measures that consumers might take to control the loss of food quality in their diets.

LEVEL: Senior High School

SUBJECTS: Science
Social Studies

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: Floretta McKenzie. Competency Based Curriculum Guide: Science and Social Issues, 1983, pp. 162-165.

ACTIVITY 1: Plan a field trip to a food processing plant so that students may get first-hand experience concerning the preparation of foods for the consumer market. Have each student write a short description of the trip.

ACTIVITY 2: Divide the class into four groups and have each group research one of the following methods of food processing:

-canning
-freezing
-drying
-freeze-drying

The research should include:

a. A brief description of the stages or steps involved in each processing method.

b. The names of some major firms or companies which utilize that form of processing.

c. A description of how the food is changed or altered as it is being processed.

d. A list of advantages and disadvantages of processing in terms of maintaining the highest nutritive value of food.

e. A list of foods which are manufactured by the various processing methods.

Once the research has been completed, each group should present its information to the class. The teacher should help in compiling all major points in a classroom chart. Below there is a sample classroom chart:

Processing Foods--The Effect on Food Quality

Method of Food Processing	Steps Involved: What is done to the food	Steps Involved: How is food changed	Advantages of Processing	Disadvantages of Processing
1. Freezing				
2. Canning				
3. Drying				
4. Freeze-drying				

ACTIVITY 3: Have students conduct research on natural and organic foods. Following the research, stage a debate on the question "do natural foods have greater nutritive value than processed foods?"

ACTIVITY 4: Discuss the impact that advertising has on the selection of the types of food that consumers buy, and consequently the quality of food they consume. Listed below are some suggested activities to illustrate how advertising influences the buying habits of consumers in the food market.

a. Recite or sing the opening lines to a catchy food advertising jingle and ask how many of the students can complete it. Also determine how many of have actually tried the product and their reasons for buying that product. Discuss the implications of the class' findings.

b. Bring in some cola (all the cola should belong to the same brand) and distribute in three containers. Label the containers--A, B, and C and inform the class that you are conducting a taste preference test. Further inform them that each container has a different brand of cola--container A, the most expensive brand, container B, a moderately priced brand, and container C, the least expensive brand. Ask them to drink the samples offered from each and list them in order of preference. Discuss with the students the implications of their findings.

(NOTE: In previous tests, a few persons have stated that all the samples tasted the same; however, many actually preferred one sample over the others.)

c. Have students research the question "should food advertising on television for small children be curtailed?". Once research is complete, assign the roles of food advertisers and consumers to various students to present the varying viewpoints.

ACTIVITY 5: Have students compile a list of various federal and local agencies and organizations which are responsible for insuring a safe and pure food supply. A sample format is listed below.

Agency or Organization	Responsibility of Agency	Problems the Agency Handles
I. Government Agencies		
A. Food and Drug Administration	A. Enforces regulations concerning the processing, labeling and marketing of foods and drugs.	A-1. Foreign substances (glass) found in food A-2. False or misleading food labeling
B. Dept. of Agriculture		
II. Organizations		
A. Nutrition Foundation		
B. World Health Organization		

6. Based upon the student discovered disadvantages associated with processed as well as natural foods, along with the list of watchdog agencies and organizations, have students generate a list of:

   a. the things that they can do to prevent or control their intake of poor quality food.

   b. the things that consumers can do to improve the quality of food on the food market.

ANALYSES OF POLLUTANT GASES

PURPOSE: To demonstrate the presence of carbon monoxide gas in the air.

LEVEL: Senior High School

SUBJECT: Chemistry

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Eileen G. Brennan and John J. McGovern, editors. Source Book on Air Pollution Topics for Grade and High Schools, 1984, pp. 137-138.

BACKGROUND: There are three classes of pollutants: particulates, gases, and liquids. Particulates are easier to see because some fall out of the air, they reduce visibility, and they cause staining on filters. Gases, on the other hand, are more difficult to detect because you cannot see them. Consequently, sophisticated scientific techniques are needed to measure the amount of these pollutants in concentrations normally found in the atmosphere.

In high concentrations, pollutant gases can be measured by pollutant detector tubes. These tubes are available for many gases. This experiment illustrates the use of such tubes for the detection of carbon monoxide. The U.S. Air Quality Standard for carbon monoxide is 35 parts per million (ppm) for 1 hour and 9 parts per million (ppm) for 8 hours. Air containing concentrations below the standards is considered safe to breathe.

MATERIALS: One carbon monoxide detector tube with a minimum detection level of 5 ppm; several refill cartridges.

(Normally, a cartridge can be used only once. However, if each subsequent test measures a higher concentration, the cartridge can be used more than once. For example, a single cartridge could be used to measure carbon monoxide concentrations in this order--10 ppm, 20 ppm, 30 ppm, etc. Once the cartridge measures 30 ppm, however, it cannot be used to measure concentrations of 30 ppm or lower again. Consequently, several refill cartridges may be required.)

ACTIVITY:

1. In the school parking lot, use a carbon monoxide detector tube to pull in a sample of air. Record the concentration of carbon monoxide. If the tube does not detect any carbon monoxide, the concentration is 5 ppm or less.

2. The teacher should turn on the ignition of a late-model automobile and collect a sample of air from near the car's tail pipe. Record the concentration. If possible, this

experiment should be repeated using a pre-1968 automobile. (Beginning in 1968, the automobile industry began to install air pollution control devices in the exhaust systems of all new cars.)

3. At a busy intersection, use the detector tube to take a sample of air. Record the concentration.

4. Compare the concentrations of carbon monoxide which were found.

DISCUSSION:

1. What is the U.S. Air Quality Standard for carbon monoxide? Determine how this standard was chosen.

2. The automobile produces the major source of carbon monoxide by the incomplete combustion of gasoline. Discuss why the concentrations you measured were different. Why did the pre-1968 car produce more carbon monoxide?

3. Prepare a report on the history of air pollution control devices for automobiles.

4. When motor vehicles are properly tuned, less pollution is emitted. Make a survey of several people who drive to determine when their cars had their last tune-up.

5. List the major gaseous air pollutants and their origin.

OCEAN RESOURCE MANAGEMENT

PURPOSE: To examine the issues involved in managing the sea and its resources.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPTS: Environmental management involves the application of knowledge from many different disciplines.

A variety of institutional structures is involved in planning and managing the environment.

REFERENCE: Michael J. Caduto, A Guide for Environmental Values Education, 1985, Exercise 6.

ACTIVITY 1: The United Nations Conference on the Law of the Sea is attempting to formulate conventions on exploitation of the oceans and their resources. No convention has yet been acceptable to the nations meeting at the conferences. Meanwhile, some countries are unilaterally claiming rights to the sea and seafloor up to 200 miles from the coast.

In class, hold a bargaining session between "countries" having an interest in owning or sharing the sea and its resources. Divide the class into sections representing countries. One country should be inland, with no borders on the ocean, but with a definite interest in mining the seabed for manganese nodules and drilling for oil; another country's coastline should be within 200 miles of yet another country, situated on an island. Try to reach an agreement on ownership or sharing of the sea and its resources.

ACTIVITY 2: A country has been conducting an island watch in the western area of the Pacific Ocean in the hope of being the first country to spot the birth of an island. If it is the first to spot such an island, the country would claim territorial rights to the island and up to 200 miles of ocean and sea floor off the island's coast.

Let's say the country claims a new island and proceeds to claim also the sea's resources for 200 miles around the island. In ten days, the island erodes and disappears. Should the country continue to lay claim to the area around the former island?

ACID RAIN

PURPOSE: To identify the chemical bases of acid rain, and to assess some of its impacts on the environment.

LEVEL: Senior High School

SUBJECTS: Physical Science
Chemistry

CONCEPTS: Natural resources are interdependent, and the use or misuse of one will affect others.

Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Douglas A. Roberts, et al. Chemical Change: A Teacher's Manual for General Level Program Development, Grades 9 and 10, 1986, pp. 65-67.

BACKGROUND: Reading #1

Air pollution happens when undesirable substances are poured into the atmosphere. Almost anything that is not normally in the air due to natural processes is undesirable and is called a pollutant. Some pollutants are gases.

Even carbon dioxide which is normally present in the atmosphere (from living organisms) dissolves in water to give a pH of about 5.7 (slightly acidic). The word equation is:

WATER + CARBON MONOXIDE ⟶ CARBONIC ACID.

If you have found pH values of lower than 5.7 , it indicates that other materials add to the acid content. Sulphur dioxide is one such gas. It is given off in industrial processes such as the smelting of metals and the burning of materials which contain sulphur.

A smelting process, such as that used to purify nickel in Sudbury, Ontario, pours tons of sulphur dioxide into the atmosphere every day. The burning of coal and oil (which contain sulphur) also adds to the sulphur dioxide in the atmosphere. This produces acid rain (two steps):

1. SULPHUR DIOXIDE + OXYGEN ⟶ SULPHUR TRIOXIDE
2. SULPHUR TRIOXIDE + WATER ⟶ SULPHURIC ACID

Sulphuric acid shows up in rain water: a pH value lower than 5.7. It lingers in water vapor in the air and is harmful to living things. In animals it attacks lung tissue; its effects can be fatal. It attacks plant vegetation as well.

When acid rain falls it also attacks other things, like buildings. For example, the beautiful statues and building ornamentation in the city of Venice, Italy, are being "erased." The stone of which these statues and buildings are made is mostly calcium carbonate (limestone, marble). The factories in and around Venice have produced high levels of sulphur dioxide for many years, so that the level of acid rain is quite high. It attacks the calcium carbonate in the buildings. The word equation for this chemical change is:

CALCIUM CARBONATE + SULPHURIC ACID ⟶ CALCIUM SULPHATE + WATER + CARBON DIOXIDE.

The air in and around Venice is quietly having an effect on buildings and sculptures. Closer to home, the effects of acid rain are seen in the erosion of buildings and statues--also tombstones, as the next reading points out.

Reading #2

Tombstones are being examined by U.S. scientists to investigate acid rain in North America. About 2.5 million marble tombstones have been placed by the U.S. Veterans Administration since 1875 in various parts of the U.S. They are made, relatively uniformly, of calcium carbonate from three quarries. They have been subject for a known time span to the influence of the atmosphere in a wide variety of environments.

Investigating the erosion of their surface and edges may allow researchers to come to conclusions about the history and long-term effects of acid rain on this continent.

(Based on "Tombstones talk about acid rain," in Legacy, March-April, 1980.)

Reading #3

What is causing the acidity of rain water and snow? A number of different studies have established the culprits as sulphuric acid and nitric acid.

Sulphuric acid begins with the burning of fossil fuels such as petroleum, gasoline, and coal. Factories and power plants in the East and Midwest U.S.A. spew enormous quantities of sulphur oxides into the atmosphere. In the presence of air moisture, the gases are converted into sulphuric acid, which is then carried to the earth's surface in rain and snow. As we use up reserves of low-sulphur gas, oil, and coal, we turn to high-sulphur coal for energy.

Nitric acid begins when automobile owners turn the ignition key. Most nitrogen oxides in the atmosphere are produced by burning gasoline. Nitric acid is then produced in the moisture of the air from these oxides, and precipitated in rain and snow.

Because of wind patterns and the easterly flowing air masses, large quantities of similar air pollutants from the U.S. and Canadian Midwest are added to those produced in the East. As a result, the eastern half of the continent receives an unusually large amount of acid precipitation. In fact, the acidity of rainfall has increased fortyfold in the past 35 years. Rain water with a pH of 4 is now common, and samples with a pH of 2.1 have been collected. (A solution with pH of 3 is as acid as vinegar.)

(Based on "Identifying the culprits," by A. H. Drummond Jr., in The Science Teacher, January 1979.)

ACTIVITY:

1. Name three acids that can be present in acid rain.

   a) _____

   b) _____

   c) _____

2. Write two word equations for the formation of acid rain.

   a)

   b)

3. How does acid rain affect buildings and statues? Write the word equation for the chemical change that happens to buildings made of marble and limestone.

   _____

   _____

   _____

   _____

   _____

RECOMBINANT D.N.A.

PURPOSE: To identify the social, political, scientific, moral/ethical, and economic consequences of research in genetic engineering.

LEVEL: Senior High School

SUBJECTS: Biology
Social Studies

CONCEPTS: A cultural and time lag exists between the development of knowledge in science and technology and application of that knowledge to resource and environmental problems.

There are certain risks taken, and limitations experienced, when manipulating the natural environment.

REFERENCE: Staten Island Continuum of Education. Contemporary Issues in Science, Implementation Manual, 1982, pp. 81-82.

BACKGROUND: Exposure to mutagenic agents, such as the ultraviolet light emitted by the sun, results in the production of faulty replication and subsequently cell division. Safeguarding the integrity of the genetic material is the capacity of D.N.A. to excise and digest the offending segment and replace it with a copy of the original. This editing and reconstruction process can be artificially induced so that the introduction of foreign D.N.A. fragments (those extracted from another kind of organism) will result in the creation of novel, hybrid D.N.A. The presence of this D.N.A. confers upon its possessor talents which are not typical of the species. It is referred to as recombinant D.N.A.

Public apprehension was elicited by the implications of genetic engineering. Suppose the genes of normally harmless bacteria were spliced with the genetic instructions from another organism which coded for the production of toxins. Further speculation revealed the possibility that bacteria which were sensitive to anitbiotics might become resistant as a result of recombinant D.N.A. Proposed experiments utilizing the cancer causing SV 40 virus aroused public fears. Man is not directly endangered by the virus which usually affects monkeys. The hazards lie in the fact that viral D.N.A. was being combined with the D.N.A. of E. Coli--a bacterial inhabitant of our digestive tract, to which we are highly receptive. What if these bacteria, modified by a cancer gene, were to escape? Even favorable recombinants, whose potential value to society was obvious, came under attack. For example, the General Electric Company had created a microbe which possessed the genetic blueprints to "eat" oil spills. Our ecological gold mine, however, could prove to be an economic disaster if these organisms were to escape into fuel supplies. Biology will have extended its boundaries to a point where even our cars could get an infection!

Scientists' recognition of the potential biohazards of genetic engineering motivated a series of self-scrutinizing conferences. This awareness was formally demonstrated at the Gordon Research Conference on Nucleic Acids in 1973 during which scientists wrote an open letter to Science, stressing caution. The following year, discussions at the Massachusetts Institute of Technology induced Berg (known for his SV 40 virus studies) to advocate a voluntary moratorium on genetic engineering within the scientific community. At the 1975 Asilomar Conference, scientists voted to self-regulate recombinant D.N.A. experiments, and finally in 1976, the National Institute of Health designed and implemented a formal set of safety guidelines. These, however, were either relaxed or eliminated in 1978.

In spite of initial hesitancy, which ranged from wariness to panic, genetic engineering has endured. In fact, this new frontier in biology may prove to be a profitable venture in business. The notion of utilizing recombinants as chemical factories capable of synthesizing insulin, vitamins, or the clotting factor has stimulated the inception of such corporations as Genetech (1976), Genex (1977), and Biogen (1978). Several companies are seeking patents for their "original" organisms. Do they have a right to claim, as their own, a reshuffled product of nature? A more altruistic avenue of genetic engineering centers on the possibility of utilizing recombinant D.N.A. to make interferon. This virus fighting substance occurs naturally in man and may be used to cure many diseases--perhaps even cancer.

ACTIVITY: Questions for Discussion:

1. Social--Who might benefit or suffer from the results of recombinant D.N.A. research? What information does the public require (and how can it be made available) to make logical, valid decisions regarding genetics engineering?

2. Political--How can the government design and implement regulatory guidelines?

3. Scientific--What are the benefits and risks associated with genetic engineering?

4. Moral/Ethical--What is the relationship between pure scientific inquiry and potential dangers to safety?

5. Economic--Should recombinant products be patented? Should recombinant techniques be patented?

IMPACTS OF THE AUTOMOBILE

PURPOSE: To consider the positive and negative social and environmental impacts of the automobile.

LEVEL: Senior High School

SUBJECTS: Industrial Arts
Science
Social Studies

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: Donald Maley, editor. Math/Science/Technology Projects for the Technology Teacher, 1985, pp. 41-42. Activity developed by James M. Smith.

BACKGROUND: The automobile has caused great changes in our society, both good and bad. Earliest attempts at a self-propelled vehicle used steam power, but this proved to be impractical. The internal combustion engine was first developed in the late 1800s, and became the industry standard in the early 1900s. Many changes in specific technologies have altered the details--and impacts--of the automobile since that time, but the internal combustion engine remains the motive force.

ACTIVITY: As a research project, students should investigate both social and environmental impacts of the automobile and the internal combustion engine, both historically and currently. Among them are:

- increases in mobility of people;
- increases in agricultural productivity;
- the development and maintenance of highway systems;
- development of mass production methods;
- dramatic changes in human lifestyles;
- increased employment in automobile production and many associated areas;
- dramatic increases in demand on natural resources;
- effects on petroleum reserves;
- development of synthetic fuels;
- pollution of air and water;
- creation of traffic congestion.

There are many others. The emphasis of the research project should be directed toward identification and analysis of both positive and negative impacts, both social and environmental.

IMPACTS OF HYDROELECTRIC POWER GENERATION

PURPOSE: To consider the positive and negative social and environmental impacts of the hydroelectric generation of power.

LEVEL: Senior High School

SUBJECTS: Industrial Arts
Science
Social Studies

CONCEPT: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

REFERENCE: Donald Maley, editor. Math/Science/Technology Projects for the Technology Teacher, 1985, pp. 50-51. Activity developed by John Walstrum.

BACKGROUND: The world's first hydroelectric power plant, on the Fox River in Appleton, Wisconsin, generated electricity for commercial use in 1882. A major improvement in this technology was the development of alternating current systems, necessary for long-distance transmission, at a later date. In the United States, the potential for the continued development of hydroelectric power sites is limited; after ten decades, the sites appropriate for such use have already been exploited. However, the same is not true for much of the rest of the world, particularly the developing countries.

ACTIVITY: As a research project, students should investigate both social and environmental impacts of the hydroelectric generation of power, both historically and currently. Among them are:

- Dams constructed for power plants create public water sources;
- Hydroelectric power is "cleaner" to produce than are fossil fuel power and nuclear power, as well as being cheaper;
- Dams create inland waterways;
- Dams create opportunities for recreation areas;
- Dams create an obstacle to fish migration;
- Watersheds created by the dams provide wildlife habitat.

There are many others. The emphasis of the research project should be directed toward identification and analysis of both positive and negative impacts, both social and environmental.

ENVIRONMENTAL IMPACTS OF RESOURCE DEVELOPMENT

PURPOSE: To identify the environmental impacts of development of a mineral resource.

LEVEL: Senior High School

SUBJECTS: Science
Social Studies

CONCEPTS: Management is the result of technical and scientific knowledge being applied in a rational direction to achieve a particular objective.

Natural resources are interdependent, and the use or misuse of one will affect others.

There are certain risks taken, and limitations experienced, when manipulating the natural environment.

REFERENCE: Council on Environmental Quality. Environmental Quality 1980, pp. 331-332.

BACKGROUND: As demand for a given resource increases, intensified effort must be expended both to find it and to develop it. These efforts often are in the areas of exploration for new reserves and in the development of new production technologies, along with increases in prices of the raw resource itself. An additional area of concern relates to the environmental impacts resulting from exploration, extraction, and development. The following case study, from Environmental Quality 1980, pp. 331-332, provides an example of the conflicts generated between need for development of a natural resource and desire to minimize negative environmental impacts:

> "World phosphate rock demand is projected by the Bureau of Mines to rise from its 1978 level of 125 million tons to 365.3 million tons per year by 2000. The United States is currently one of the world's leading suppliers of phosphate rock. If U.S. production is stepped up to meet increased world demand, environmental problems associated with the mining and processing of phosphates will increase unless resource management policies are improved. Mining and processing of phosphate require vast quantities of water, can scar the landscape, and release radioactive radium and radon gas into water and the air.
>
> "Because many of the U.S. phosphate reserves are on public lands administered by the Forest Service or the Bureau of Land Management, the federal government has the opportunity to consider how this resource is to be developed and to what extent the environmental costs are controlled.

"Florida's Osceola National Forest contains substantial phosphate reserves. The federal government acquired most of this land under the Weeks Act of 1911 for timber production and wetlands protection. The BLM is responsible for issuing mineral leases on the land, although the Forest Service must first approve the leasing terms."

Between 1963 and 1968, the Department of the Interior, with the approval of the Secretary of Agriculture, issued 92 permits to prospect for phosphate on the Osceola National Forest. By 1969, four companies had filed 41 applications for preference right leases based on their prospecting efforts. These applications cover 52,000 acres--34 percent of Osceola--the majority of the land in the western half of the Forest.

"Whether to grant leases is a decision to be made by the Department of the Interior. EPA and the State of Florida have opposed issuance of the leases on environmental grounds, stating that the leases would not be in the public interest because phosphate mining in the Osceola Forest might well result in the permanent loss of 28,000 acres of wetlands and productive forest. Such a loss would be contrary to purposes for which the land was initially acquired.

"Phosphate mining could have other adverse effects, including drawdown of the artesian Floridian aquifer system, increased levels of radon and radium, and increased sediments in surface waters, including the Suwannee River. In addition, large bermed "slime ponds" would be constructed either within or adjacent to the Forest and would contain thousands of acre-feet of phosphate clay slurry produced during extraction. EPA referred this controversy to CEQ, stating that the proposed leasing alternatives being considered by Interior were environmentally unsatisfactory.

"After discussions among representatives of CEQ, Interior, EPA, and the Forest Service, the Secretary of Interior announced that the Department would support legislation which:

- Precludes phosphate development in the Osceola National Forest, and
- Directs the Secretary of Interior to determine whether any lease applicants are legally entitled to phosphate mining leases; if so, the lease rights would be exchanged for leases covering minerals on other public lands, or, if no exchange were possible, compensation would be paid."

ACTIVITY: Discussion questions relative to this case study might include:

1. How is the decision to "go ahead" for the development of such a mineral resource made? Is this the best way? What other methods might be used?

2. Is it possible that there might be a case where environmental considerations preclude the development of a mineral resource? If not, why not? If so, what might be the rationale, or rationales?

Cases involving similar development-environmental tradeoffs abound. Students may wish to investigate other examples, such as the development of oil shale, strip mining, etc. The teacher should ascertain that "pro-development" arguments, by themselves, or "pro-environmental" arguments, by themselves, are not presented as definitive arguments "for" or "against" development, but that students are required to investigate, document, and present both sides of each case. A debate presenting "for" and "against" arguments may be a useful device.

AQUIFERS

PURPOSE: To assess implications involved in groundwater use and management.

LEVEL: Senior High School

SUBJECT: Science

CONCEPTS: Environmental management involves the application of knowledge from many different disciplines.

Natural resources are interdependent, and the use or misuse of one will affect others.

REFERENCE: Staten Island Continuum of Education. Contemporary Issues in Science, Implementation Manual, 1982, pp. 75-76.

BACKGROUND: Four-fifths of our planet's surface is occupied by water, but you can't see most of the earth's fresh water. Ninety-seven percent of our fresh water is located underground where it accumulates naturally in reservoirs referred to as aquifers. The sub-surface water has many names such as ground water, spring water, well water, mineral water, and, if it has bubbles, Perrier. Ground water results from the seepage of surface water (from lakes or precipitation), down through permeable soil until it reaches a level of saturation, referred to as the water table. It is capable of "flowing," but its movement is much slower than that of surface water, such as a river, and is measured in mere feet per year. Why does this underground water supply, which is at least temporarily removed from the traditional evaporation-condensation-precipitation water cycle, warrant our attention? Twenty-five percent of the fresh water used in industry, in agriculture and for drinking is obtained from this underground source. Furthermore, the use of ground water had increased since 1950 by more than 140% and will probably continue to do so, in response to man's increasing demands on our natural resources. Recent investigation, however, has indicated the presence of pollutants in many aquifers--an assault on nature which is proving difficult to arrest and potentially impossible to reverse.

Historically, ground water has been considered the purest water, a reputation which at first glance is justified. As tiny droplets of water percolate through soil particles, they become cleansed via a physical process (filtration), a chemical process (absorption), and a biological process by the ecological intervention of microbes. Certain pollutants, however, are immune to this natural cleaning process either because of their particular chemistry or because of the excessive quantities present. Once the tainted water reaches the level of the water

table, it may remain there indefinitely or seep to other aquifers. Further natural cleaning does not occur at the level of saturation where conditions are abiotic. Tests have indicated the presence of toxic organic and inorganic chemicals in drinking water extracted from underground wells. Particularly worrisome are the levels of chlorinated hydrocarbons which were observed, because these do not occur in nature (as do some of the heavy metals, such as zinc), and they are harmful in very low concentrations. (Anything greater than 10 parts per billion is considered hazardous.)

Chlorinated hydrocarbons are odorless and tasteless. They may be potentially mutagenic and carcinogenic, and their effects are unpredictable. Low dosage exposure over an extended period of time may produce a cumulative effect, and interaction with other compounds at "safe" levels may produce deleterious effects. Finally, the establishment of safe or non-risk levels is a subject of considerable debate and inconsistency.

Assuming that contamination of ground water is a problem, what courses of remedial and preventative action are feasible? Cleanup techniques are inconvenient and expensive because of the location of ground water. Ascertaining the extent and location of contamination is also difficult because ground water movement is erratic and hidden from view. According to the U.S. E.P.A., industrial impoundments and landfills are the greatest contributors to ground water pollution. Secondary sources are municipal waste water, mining, petroleum production, and septic tanks.

ACTIVITY: Questions for Discussion

1. Social--Who enjoys the immediate and long-term benefits of ground water use, and are these the same people who are likely to suffer the deleterious effects of contaminated water?

2. Political--How could government prevent further contamination and implement clean-up programs? What has government done already?

3. Scientific--What are the "safe" levels for various contaminants and how reliable are the established safe levels?

4. Moral/Ethical--Who should have the right to answer 1, 2, and 3. Why?

5. Economic--Where should money to accomplish testing, restricting, clean-up, etc. come from?

RESOURCES AND RESERVES

PURPOSE: To understand how supplies of natural resources change with changes in scientific knowledge, economic considerrations, and technologies.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPTS: Social and technolgical changes alter the interrelationships, importance, and uses for natural resources.

The distribution and location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

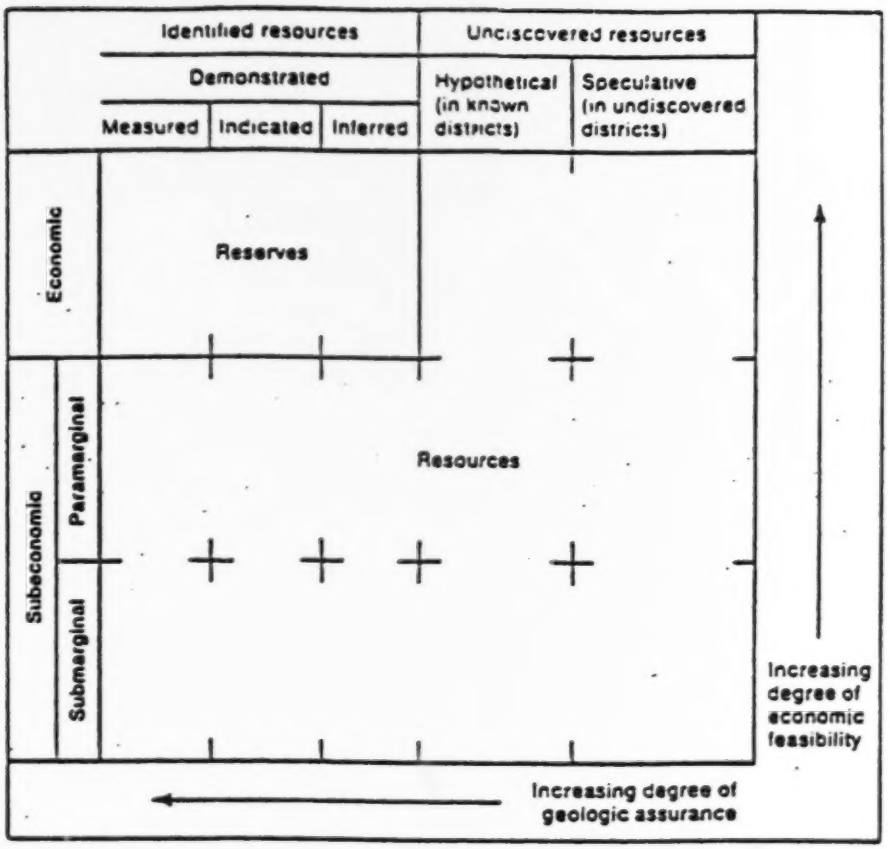
Natural resources are interdependent, and the use or misuse of one will affect others.

REFERENCE: Mary Lynne Bowman. Teaching Natural Resource Management through Environmental Education Activities, 1981, pp. 159-162.

BACKGROUND: It is obvious that, in the cases of non-renewable natural resources, finite supplies exist in, on, and under the surface of the earth. A number of methods of "extending" these supplies exist--conservation, recycling, and the like. But short of non-use and/or 100 percent recycling, eventually all of these resources will be depleted.

However, the process of establishing clearly how much longer any given non-renewable resource will last is complex. A number of assumptions must be made if one is to project any such time line. It is often assumed that current or recent-historical use patterns will continue into the future, and that currently-known resources represent the total amount of any given resource ever likely to be available for use. Such assumptions are at best simplistic, and at worst misleading to the point that they develop completely erroneous conclusions, upon which faulty resource management decisions may be baed.

The U.S. Bureau of Mines and U.S. Geological Survey in assessing total mineral resources of the United States currently use a classification scheme which considers two prime elements of information--the degree of certainty about the existence and magnitude of supplies of these materials and the economic feasibility of recovering them. The diagram on the following page, along with accompanying definitions of terms, summarizes this scheme.



In this system, "reserves" (upper left) are those resources known to exist and to be recoverable. At the opposite extreme (lower right) are poor-grade deposits that may exist in unexplored areas. The following definitions provde additional information:

Resource

A concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust in such form that economic extraction of a commodity is currently or potentially feasible.

Identified Resources

Specific bodies of mineral-bearing material whose location, quality, and quantity are known from geologic evidence supported by engineering measurements with respect to the demonstrated category.

Undiscovered Resources

Unspecified bodies of mineral-bearing material surmised to exist on the basis of broad geological knowledge and theory.

Reserve

That portion of the identified resource from which a usable mineral and energy commodity can be economically and legally extracted at the time of determination. The term ore is used for reserves of some minerals.

The following definitions for measured, indicated, and inferred are applicable to both the Reserve and Identified-Subeconomic resource components.

Measured

Material for which estimates of quality and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.

Indicated

Material for which estimates of the quality and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.

Demonstrated

A collective term for the sum of materials in both measured and indicated resources.

Inferred

Material in unexplored extensions of Demonstrated resources for which estimates of the quality and size are based on geologic evidence and projection.

Identified-Subeconomic Resources

Materials that are not Reserves, but may become so as a result of changes in economic and legal conditions.

Paramarginal

The portion of Subeconomic Resources that (a) borders on being economically producible or (b) is not commercially available solely because of legal or politicial circumstances.

Submarginal

The portion of Subeconomic Resources which would require a substantially higher price (more than 1.5 times the price at the time of determination) or a major cost-reducing advance in technology.

Hypothetical Resources

Undiscovered materials that may reasonably be expected to exist in a known mining district under known geologic conditions. Exploration that confirms their existence and reveals quantity and quality will permit their reclassification as a Reserve or Identified-Subeconomic resources.

Speculative Resources

Undiscovered materials that may occur either in known types of deposits in a favorable geologic setting where no discoveries have been made, or in as yet unknown types of deposits that remain to be recognized. Exploration that confirms their existence and reveals quantity and quality will permit their reclassification as Reserves or Identified-Subeconomic resources.

ACTIVITY: Based on the information provided above, the following questions may be addressed:

1. What role is played by mineral exploration in the identification of "new" mineral reserves?

2. What role is played by improvements in the technologies of mineral extraction and/or processing in the identification of "new" mineral reserves?

3. What role is played by changing economic conditions in the identification of "new" mineral reserves?

4. What role is played by the substitution of one substance for another in the production of desirable products in the distinction between "resource" and "reserve" for each substance?

NOTE: This activity can, depending on the objectives of the course or teacher, the abilities of the students, and the interest generated, become the basis of extensive research and understanding. The creative teacher will be able to relate it to many of the other activities in this volume, and to any number of specific cases.

LONG-RANGE PLANNING

PURPOSE: To investigate interrelationships between the natural resource base and demands on it in the framework of long-range resource management planning.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPTS: Social and technological changes alter the interrelationships, importance, and uses for natural resources.

A cultural and time lag exists between the development of knowledge in science and technology and application of that knowledge to resource and environmental problems.

Options available to future generations must not be foreclosed.

REFERENCE: Mary Lynne Bowman, Teaching Natural Resource Management through Environmental Education Activities, 1981, pp. 174-175.

BACKGROUND: Much of the "business" of the natural resources manager is in forecasting future demand for specific resources. Accurate forecasts facilitate the development of resources so that they will be available at the points in time when they are needed.

Historically, these projections have been short-term (one to five years). They have generally been cast in economic terms, with economic benefits and costs as primary considerations. Particularly in nations like the United States, an implicit assumption has been that, if accurate forecasts of future needs for specific resources are known, the resources themselves will be located and/or developed without undue difficulty. This attitude is often referred to as the cornucopian philosophy, which basically assumes that there is a never ending supply of resources the development of which is dependent only upon the ingenuity of those developing them.

Another school of thought points to the increasing complexity of resource supply and demand, in large part triggered by rapid population growth both locally and worldwide. Those espousing this philosophy are more pessimistic in their long-range forecasts; they generally forecast the time when the resource base will no longer be able to support the earth's population.

ACTIVITY: Students may wish to investigate the forecasts of "futurists" who have paid particular attention to the impacts of modern conditions and trends on the resource base. Among them have been:

1. Thomas Malthus, the various versions of whose essay "A Summary View of the Principle of Population" in the 1800s considered relationships between expotential population growth and arithmetic growth in availability of food;

2. Jay Forrester, whose book World Dynamics (Cambridge, Massachusetts, Wright-Allen Press, 1971) reported computer studies of the global interrelationships among population growth, natural resource depletion, economic patterns, agricultural development, and increasing pollution;

3. D. H. Meadows, D. L. Meadows, J. Randers, and W. Behrens, whose report, The Limits to Growth (New York, Universe Books, 1972), explored further the work of Forrester;

4. Mihajlo Mesarovic and Eduard Pestel, whose Mankind at the Turning Point (New York, Dutton, 1974), followed the Forrester-Meadows models but disaggregated the single global model into a model of ten interacting and interdependent regions; and

5. Gerald O. Barney and others, whose Global 2000 Report to the President: Entering the Twenty-First Century (U.S. Government Printing Office, 1980, in three volumes) represents the first "official" U.S. Government projection in these areas.

6. Lester R. Brown and others, State of the World 1984, State of the World 1985, State of the World 1986 (New York, W. W. Norton, 1984, 1985, 1986), which present data from an environmentalist perspective on world resource and environmental problems.

It should be noted that this is a "one-sided" list; all five of these references project an intolerable depletion of the global resource base over the next 20-50 years. Students should also investigate the reports of those who take a more optimistic view, and attempt an impartial assessment of both "sides."

Among those painting a more optimistic picture are John Maddox (The Doomsday Syndrome, New York, McGraw-Hill, 1972), and Julian Simon and Herman Kahn (The Resourceful Earth: A Response to Global 2000, New York, Basil Blackwell, 1984).

Because of the complexities of the situation, it is unrealistic to attempt to achieve resolution of the issue in the classroom, but it is appropriate to point out that those supporting either viewpoint agree that sound natural resource management policies are required, so that needs can be forecast, and met to the extent possible.

GOVERNMENT POLICIES AND TECHNOLOGICAL DEVELOPMENT

PURPOSE: To enable students to debate the question of governmental influence on scientific/technological research and arrive at their own positions about the proper role of government in this area.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPTS: A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, ethical, and economic considerations.

REFERENCE: Staten Island Continuum of Education. Contemporary Issues in Science, Course Manual, 1982, pp. 131-134.

ACTIVITY:

1. Explore the different reasons that governmental legislatively and administratively involves itself with scientific research.

   The effect and role of

   A. Special interest groups

   B. General public outcry

   C. The media stimulating an issue

   D. The scientific community

   E. Traditional values of society

   F. Sociological pressures

2. Formulate through student reporting, development learning, and position papers how each of the above forces cause governmental movement.

3. Derive a list of specific examples of legislative and administrative governmental acts or commissions that affected the direction of scientific development.

4. Enable the students to construct a table explaining the problems and benefits associated with legislative and administrative governmental action.

5. At the conclusion of this material, the student should have enough of an in-depth understanding in governmental action that he can clearly write a position paper as to the morality of the government becoming involved in scientific research.

6. Desired Content Outcomes:

   A. What are the reasons that governmental legislatively and administratively affects scientific research?

      1. Effects and roles of special interest groups

         a. Environmentalists--clean air and green belts

         b. Labor unions--asbestos and coal workers

         c. Religious groups--moral issues

         d. Health groups--cigarette smoking

      2. General public outcry

         a. Fear of pesticides

         b. Fear of the results associated with recombinant DNA research

         c. National defense--increase in military spending

      3. Media stimulating an issue

         a. Exposure of the water supply to hazardous wastes

         b. The real threat of nuclear reactors that are not constantly screened--Three Mile Island

         c. Books like Silent Spring by Rachel Carson exposing the dangers of pesticides.

      4. Scientific Community

         a. Warnings of chemical pollution, birth defects, and carcinogens are but a few in which scientists themselves alerted the population to control.

5. Traditional values of society

   a. The type of laboratory subjects that will be used for experimentation--animal or human.

   b. The moral parameters that will be used in the testing procedures; such as undue cruelty, unnecessary surgical procedures, etc.

6. Sociological Pressures

   a. The administrative changes in I.Q. testing which was found to be unfair to individuals who have been educationally and sociologically deprived.

B. What are examples of legislative and administrative governmental policy affecting scientific research?

1. Clean Air Act

2. Emission Control Standards

3. Standards and procedures set by the E.P.A. (Environmental Protection Agency), N.I.H. (National Institutes of Health) and Human Resources Administration

4. OSHA--Occupational Safety and Health Administration--This agency is responsible for safety standards and materials.

C. What are the problems and benefits of governmental involvement in scientific research?

1. Problems of governmental involvement

   a. Too much regulation will stifle the creativity of the scientist and direct the areas of research he performs.

   b. Excessive regulation leads to too much control of scientific research.

   c. There is a steering of research into questionable moral areas when governmental support exists.

      1. Mind Control

      2. Recombinant D.N.A.

   d. A question arises as to the cost effectiveness of governmental regulations.

2. Benefits of governmental involvement

a. There is a yield of other benefits to society that flows because of funding intensity and longevity.

1. The NASA program has yielded superior transistors, micro-computers, and high resolution televisions to name a few.

b. The quality of our environment has improved.

1. Lake Erie pollution.

2. London particulates in the atmosphere.

3. OSHA regulations.

c. The quality of our working place has improved

1. Coal mines--decrease in black lung disease.

2. Asbestos workers wear masks and have proper ventilation.

d. The quality of our health and safety has improved.

1. Flammable resistant pajamas for children.

2. School innoculations.

SUMMARY:

1. What are the forces exerting influence in society that cause governmental controls affecting scientific development and research?

2. What are the problems and benefits that are encountered as a result of governmental involvement in scientific research?

3. How do political influences affect governmental programs and what do you predict will occur in the next five years?

4. How has society benefited or been hurt by the great amount of governmental control of scientific research?

5. Project yourself to the year 2050 A.D. What effects do you think government will have on scientific research?

EFFECTS OF TECHNOLOGIES

PURPOSE: To call students' attention to the double-edged nature of technological innovations, and to assist them in learning to assess the likely effects of particular innovations on society, culture, and environment.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPTS: A cultural and time lag exists between the development of knowledge in science and technology and application of that knowledge to resource and environmental problems.

Options available to future generations must not be foreclosed.

There are certain risks taken, and limitations experienced, when manipulating the natural environment.

REFERENCE: Adapted from Sara F. Anderson, Wielding the Double-Edged Sword: Techniques for Teaching about Technology-Related Issues, 1984, pp. 1-4.

ACTIVITY: Choose one past technological innovation, e.g. electricity, the railroad, television, and answer each question in Part I. Base your answers on your knowledge of history and the effects that innovation has had. Condense your answers onto the chart for Part I.

In Part II, follow the same procedure for a current innovation--personal computers, animal organ transplants to humans, in vitro fertilization of human ova, nuclear power plants. Base your answers on your observations of current trends as well as "brainstorming" for likely effects.

In doing both parts, keep in mind the nature of the cultural system and the environment. A change in one part causes changes in many other areas. In the past, most of these systemic changes have been unplanned and unforeseen. With the advantage of several decades of experience, we now can be alert to the "double-edged" nature of any innovation; it cuts toward the planned benefits for which we adopt it and ubt it also cuts toward unplanned effects in other parts of the cultural system and the environment than the one in which the innovation is introduced.

PART I. A HISTORICAL VIEW OF TECHNOLOGICAL INNOVATIONS.

1. List all the effects you can think of for one technological innovation introduced into our culture during the past 85 years.

2. Categorize the effects on your list according to whether they were planned and/or foreseen by those who introduced or adopted the innovation or were unplanned and unforeseen.

3. Indicate which effects were felt only in a local area, which were felt regionally, nationall and globally.

4. Divide the effects on your list into those you consider "positive," that is benefitting people in general and "negative," that is those which were harmful.

5. In the "Quality of Life" column of the chart, list four factors you consider essential to a good quality environment for human beings, and which influenced your choices in item #4.

6. Which subgroups in society benefitted most from the innovation you are assessing? Which subgroups of society bear (or did bear) the majority of the burdens of the negative effects? List two reasons for the inequitable distribution of benefit and burden.

7. What effects did this innovation have on the environment?

8. What was the timelapse between (a) the scientific or technological discovery which made the innovation possible and its widespread introduction or adoption? (b) between the planned benefits and the appearance and/or awareness of the burdens?

9. a. What actions have been/are being taken to alleviate the burdens?

   b. Who (government, industry, consumers) are taking these actions?

   c. Who is paying the cost of alleviating these burdens in money?

   d. Who is paying the cost of alleviating these burdens Quality of Life?

10. What areas of choice did the innovation open up for individuals?

11. What choices did the innovation open up for in society in general (seen most likely in legislative and judicial decisions)?

PART II. AN ASSESSMENT OF THE LIKELY EFFECTS OF A TECHNOLOGICAL INNOVATION CURRENTLY BEING ADOPTED.

1. Using your observation of current trends and by "brainstorming," imagine the effects some current new technology may have during the next two decades.

2. Indicate which effects are planned or hoped-for by those urging the adoption of the innovation and by those adopting it. Indicate which effects on your list are "unplanned."

3. Categorize the effects according to how widespread they will be--local, regional, national, and global.

4. Divide the effects on your list into those you consider "positive," that is they will be beneficial to humans or to our society and which you consider "negative" or harmful to individuals or to our society.

5. In the "Quality of Life" column on the chart, list four factors you consider essential to a good quality environment for human beings, and which influenced your choices in item #4.

6. Which subgroups in our society will likely benefit most from the innovation you are assessing? Which subgroups will bear the majority of the burdens or negative effects. List two reasons for the inequitable distribution of benefit and burden.

7. What has been the timelapse between the scientific or technological discovery which made the innovation possible, and its current status as a technological innovation being widely adopted?

   What timeperiod is likely to elapse between the planned benefits and the appearance of the burdens resulting from the innovation?

8. a. What actions are being/might be taken to alleviate the burdens?

   b. Who (government, industry, consumers) are taking/will take these actions?

   c. Who is paying/will pay the cost of alleviating the burdens? in money?

   d. Who is paying/will pay the cost of alleviating the burdens in Quality of Life?

9. What areas of choice are being opened/will open up for individuals?

10. What areas of choice are being opened up for our society, and what will be the best forum (government, industry, other groups) to make these choices?

WIELDING THE DOUBLE-EDGED SWORD -- Chart for Assessing Technological Innovations

Technology Assessed	Effects		Negative	Positive	Groups Benefited	Groups Harmed	Quality of Life	Time Span
	Planned	Unplanned						

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